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INTERIOR FACE OF THE PRINCIPAL WEST ENTRANCE.

INTERIOR ANGLE AND STEPS FROM THE SECOND TO THE THIRD INCLOSURE.

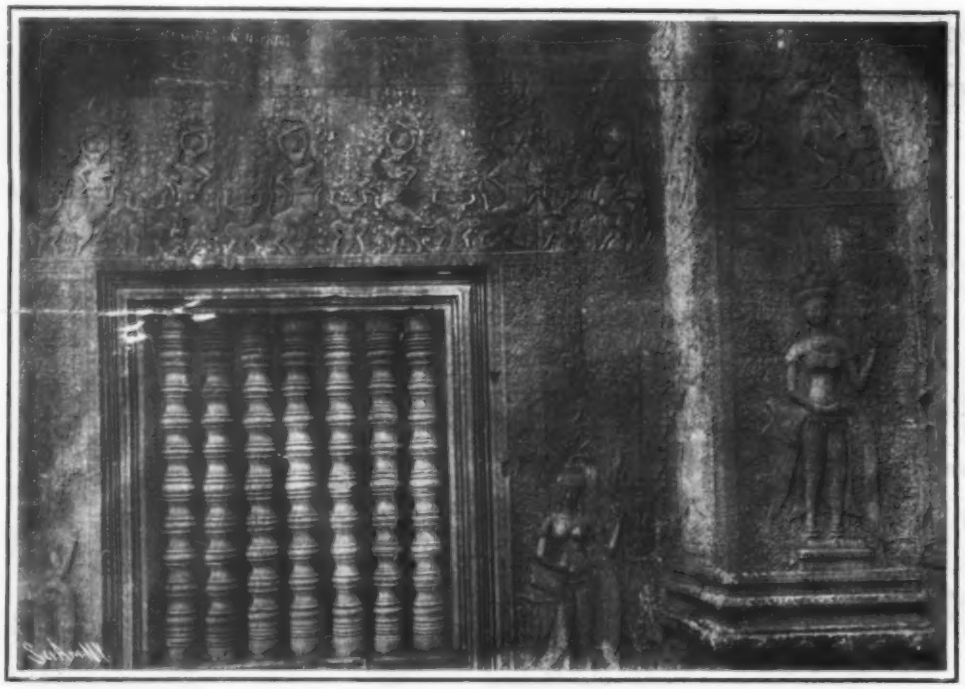
PRESERVING THE TEMPLES OF ANGKOR.

PRESERVING THE TEMPLES OF ANGKOR.

FRENCH CONTROL OF SOME OLD RUINS.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A DIPLOMATIC convention which is of great interest to archæologists in all parts of the world is the treaty which was concluded between France and Siam during the past year, by which the protectorate of the former country is extended over the Cambodian dependencies of Battambeg, Siem, Reap, and Sisophon, originally annexed by Siam. By this political development the country in which are situated those magnificent early specimens of ancient Oriental architecture, the Temples of Angkor, are brought under French control, and the republic in view of the unique interest centered in these buildings has resolved upon their complete protection. A powerful committee with this project in view has been constituted, comprising the foremost scientists, artists, savants, and archæologists of France, and considering the international importance of the preservation of these early traces of Oriental architecture, strong efforts are being made to enlist the sympathies of every other nation, in which direction striking success has already been achieved, since writers and travelers of all nationalities who have visited Indo-China and explored these buildings have written at great length concerning their beauty and far-reaching importance as a link with the early civilization and arts of the extreme East.



A SECTION OF THE REMARKABLE MURAL DECORATIONS OF THE TEMPLE.

The name Angkor, which has been given to this ancient capital of Cambodia, is derived from the Cambodian pronunciation, which according to the Sanskrit is "Nagara," meaning "capital town," the name Angkor being the equivalent of the Roman expression "urbs." The ancient official designation of the capital, however, was "Yasodharapura" from the name of the first native king who resided there, Yasovarman. Angkor is first mentioned in "Cristoval de Jague" 1596, but the attention of the public was not directed thereto until the appearance of the description written by the eminent French traveler H. Mouhot, in 1864. Since that time several other travelers and explorers have visited the country and investigated the beauties of the buildings which they have set forth at great length. At the same time, however, the most valuable and exhaustive contribution to our bibliography of the subject is that which was made by a Chinese writer, Echeon Ta-Kouan, who visited the city at the zenith of its splendor toward the end of the thirteenth century. This description was first translated from the vernacular by a well-known Frenchman, Abel Remusare, and it gives a valuable insight into the characteristics and details of the pile of buildings. It appears that the construction of the capital was commenced during the reign of Jayavarman II. during the years 802 to 869 A. D., and was continued and carried to completion by his successor Yasovarman during the years 869 to 902 A. D. Its construction thus occupied a little more than half the latter part of the ninth century. After this date the most important part of the city was carried into execution, namely the erection of the Great Temple of Angkor Vat, which dates from about the twelfth century.

The town continued to flourish and constituted the royal capital and residence of the Cambodian kings until the incursions of the Siamese compelled the natives to seek a position more inland and more inaccessible to their relentless invaders. Angkor was thus definitely abandoned, but the period of such action cannot be positively determined, though it is generally believed to be about the middle of the fifteenth century. Consequently, as a result of this migration, the temples were despoiled by vandals and permitted to fall into ruin, but this decay has now been successfully arrested before it is too late by the society pledged to their preservation, to the courtesy of whose secretary, M. Louis Finot, we are indebted for these particulars and the accompanying illustrations. Although the temples have naturally suffered, somewhat from neglect they are still in an excellent state of preservation together with their unique inscriptions and mural decorations.

The ruins of Angkor in their present condition comprise two distinct sections—first, an inclosure wall forming a rectangle nearly 1⅝ miles in length on each side; and second, a series of buildings beyond this wall, the first representing the city proper and the royal residence surrounded by the suburban or outer precincts of the city occupied by private residences situated in a wood. These have naturally disappeared in the course of time.

The interior city is surrounded by an embattled wall ranging from 22 feet to 26 feet in height. It is set toward the east, facing the Siemreap River, which flows along its side for about 1,000 feet. On this eastern or principal side the city is entered by two gates—the Gate of Victory and the Gate of Death—but each of the three other sides is provided with only one gate. Each gate is crowned by a tower centrally placed over it, flanked on either side by a smaller tower and all three in each case are decorated in the curious manner characteristic of these ancient temples of Angkor, i. e., four enormous human faces, which are supposed to represent the four visages of Brahma.

The gateways of the inclosure are approached by broad causeways which pass over the surrounding moat and which have a balustrade formed of huge seven-headed serpents held by giants. There are 108 of these giants to each gateway, making 540 figures in all.

In the center of the inclosure is the palace, of which the surrounding wall is still visible. It forms a rectangle, the longer sides of which stretch from east to west, and measures about 1,900 feet by 820 feet. But nothing remains of the pile itself except the central pyramid named Phimear Akas, meaning "aerial palace."

The royal temple still remains, though sadly ruined. This is the edifice called "Bayon," the meaning of which is uncertain, but it is one of the most beautiful of Cambodian buildings. Its imposing massiveness, the originality of its plan, and the magnificence of its decoration render it one of the chief architectural works to be found in the city. Its concentric galleries and floors are ornamented with long series of bas-reliefs which stretch for about half a mile and which constitute a document of the first order in connection with the history of ancient Cambodia. These bas-reliefs have recently been photographed in detail for the first time by a well-known French architect who made a special journey to Indo-China for the purpose.

Another important monument within the inclosure of the palace is the King Lepreux Terrace, of which the statue is one of the rarest representations of Cambodian sculpture, and the monument of Ba-Phuor, a pyramid with seven terraces, crowned by a tower formerly covered with copper and which is called the "Mont de la Corne d'Or."

The surrounding wall of the town is connected at the north and south with two prominent temples—at the north, Prakhan, and at the south, Angkor Vat. This last has been carefully preserved for its noble towers, long galleries and ornamentation which are of incomparable grace and richness in Oriental art. It dates, as we have already mentioned, from the twelfth century. At first it was a Brahman temple, but a century or so after its construction it embraced Buddhism. There are in the park to-day two monasteries, of which the oldest is named Vat, meaning convent.

In front of the east and west faces of the interior city extend two large lakes, in the center of one of which is a small temple. The eastern lake is now quite dry, but that on the west is still partly filled with water. While there are no other monuments on the eastern side of the town, there are on the western side several buildings, the principal of which are Ea Prohm and Bantcai Kedei. Altogether these remarkable temples of Angkor cover a total area measuring approximately 15½ miles by 10 miles, from which dimensions an adequate idea of their extent and magnitude may be gathered. Under these circumstances the aims of this society to secure their preservation is a decided gain to archæology and Oriental study.

THE EXCAVATIONS OF THE BRITISH SCHOOL AT ATHENS.*

By R. M. DAWKINS, M.A., Director.

THE work of the British School at Athens in the season of 1906-1907 was carried on in two different places. A subsidiary excavation was conducted at a site on the Magnesian promontory of Thessaly, while the main work of the school continued the previous season's campaign on the site of ancient Sparta.

In Thessaly some "geometric" tombs were discovered, with a rich yield of vases. Near these the foundations of an ancient church were cleared, interesting both in its plan and in its very fine mosaic pavement.

The main excavation at Sparta was chiefly directed to three objects: (1) the tracing of the course of the city wall; (2) the excavation of the sanctuary of Athena of the Brazen House; and (3) to the further excavations of the sanctuary of Artemis Orthia. With regard to the city wall, it has now been possible to trace its general course all around the *enceinte*, mainly by the stamped tiles which are found on the line where the wall previously existed, the wall itself having often entirely disappeared.

On the Acropolis, just behind the theater, were found the scanty remains of a famous temple of Athena of the Brazen House. A series of important statuettes were discovered, a long archaic inscription, and a very fine early Panathenaic amphora. There was evidence to prove that the sanctuary goes back to very early times.

The sanctuary of Artemis Orthia is now proved to consist of a temple in front of which is a large theatral building, bearing to the façade of the temple the relation of the cavea of a theater to the stage building. In the middle of the arena thus formed was found the altar of the goddess. The theater dates to the third century after Christ, and it is well known that the savage rites of Orthia lasted until the very

* Specially prepared for the SCIENTIFIC AMERICAN by the Director, R. M. Dawkins, M.A., Fellow of Emmanuel College, Cambridge, from the lecture delivered by him to the subscribers to the British School at Athens.

end of paganism. The temple itself dates from the sixth century B. C., having, however, been rebuilt in the Hellenistic period. The latest altar is Roman, but rests on the remains of an earlier Greek and probably Hellenistic altar, associated with which are a mass of charcoal and débris of sacrifices. These remains carry the site back to the sixth century B. C., but there is evidence that the cult is very much older, going back, indeed, to the earliest days of the Dorian settlement in the Laconian vale. In the sixth century the level of the sanctuary was raised some three or four feet by a layer of sand and gravel brought from the bed of the Eurotas, no doubt to avoid the danger of floods to which this low-lying site must always have been subject. After clearing away this sand, we found all over the arena and inside the temple a copious deposit, in some places as much as three feet thick, of votive offerings to the goddess. These are all certainly earlier than the sixth century B. C., while the earliest of them can hardly be later than the ninth century, thus carrying us back to the earliest Dorian period. Among these offerings and of the same date was found a very large altar resting upon a cobble pavement. This altar can, in construction, hardly be later than the sixth century, and even before it was built sacrifices were offered upon this spot. This is proved from the fact that underneath the foundations of the altar there is a quantity of burnt charcoal and bones, clearly the débris of burnt offerings. A mass of such débris surrounds the altar itself.

The votive offerings of this ancient period are of great interest and importance. The pottery ranges from Corinthian at the top of the deposit through proto-Corinthian down to a thick stratum of "geometric," thus fitting in very well with a date ranging from the sixth century backward. With this pottery were found a large number of bronzes of "geometric" style, *fibulæ*, and carved ivories. The latter, which are of unique interest, form the most important of our finds. There are many small figures, couchant animals, seals, and plaques with representations in relief. Many of these plaques adorn the brooches that were used to fasten the characteristic Dorian dress. The *fibulæ* are of great importance, as their nearest congeners are found, not in Greece, but in the iron age settlements of Austria and the Alpine region. The amber found also points in the same direction, and is a link with the same iron age find. All this evidence strongly supports the theory that the Dorians were invaders who came into Greece from the north of the Balkan peninsula, and in those early votive offerings we seem to have the peculiar jewelry and ornaments that they brought with them from their earliest homes. They brought with them also the savage rites of their goddess Orthia, whose venerated image according to the legend was actually brought to Sparta from some other place.

It is remarkable that the altars found are situated one exactly above the other, and thus show a continuous cult of the goddess on one sacred place for at least 1,200 years. The temple associated with the oldest altar and its mass of votive offerings have not yet been found, but there is evidence for supposing that its remains are hidden beneath a part of the foundation of the Roman theatral building. If this be so, it will be found that at the time of the reconstruction of the sanctuary of the sixth century, the temple was rebuilt in a new place, while the altar remained throughout in its original position as being the real center of the cult. The further excavation of the site, and in particular the search for this most ancient temple, will be the main task of the British School in the coming season.

MATHEMATICAL PRODIGIES.*

THE WONDERFUL FEATS OF BOYS WHO BECAME FAMOUS.

BY G. A. MILLER.

WHEN scarcely three years old Gauss, according to an anecdote told by himself, followed mentally a calculation of his father's relative in regard to the wages of some workmen, who were to be paid for overtime in proportion to their regular wages, and, detecting a mistake in the amount, he called out, "Father, the reckoning is wrong, it makes so much," naming the exact amount. The calculations were repeated and it turned out that the child was correct, while all who witnessed the performance were greatly surprised. He retained an extraordinary ability for mental calculations throughout life and remembered the first few decimals of the logarithms of all numbers, so that he was able to use the data of a logarithmic table in his mental calculations, and hence he possessed a mental slide rule—a unique possession.

Gauss was not only one of the greatest mental calculators on record, but he excelled equally in all branches of pure and applied mathematics. At the age of twenty he discovered the first rigorous proof of the fundamental theorem of algebra, which affirms that every algebraic equation has as many roots as its degree, and at the age of twenty-four he published his great work on the theory of numbers under the title "Disquisitiones Arithmeticæ." Later in life he turned his attention principally to applied mathematics—especially to astronomy and geodesy—and he is generally regarded as the last of the great mathematicians who were pre-eminent in nearly all branches of mathematical knowledge of his day. He considered mathematics the queen of the sciences and number theory the queen of mathematics.

While Gauss was both a great mental calculator and a great mathematician, and was a real mathematical prodigy, we proceed to consider several who were merely arithmetical prodigies and seemed to have very little general mathematical ability. The greatest of these is Dase, who was born at Hamburg in 1824, and "seems to have been little more than a human calculating machine, able to carry on enormous calculations in his head, but nearly incapable of understanding the principles of mathematics, and of very limited ability outside his chosen field." His extraordinary ability in mental calculation is evidenced by the fact that he was able to multiply mentally two numbers, each of which contained one hundred figures. It took him eight and three-quarters hours to perform this feat, which stands in a class by itself, as no other arithmetical prodigy is known to have been able to multiply mentally two numbers each consisting of more than thirty-nine figures. Two forty-figure numbers, Dase was able to multiply mentally in forty minutes, while he would multiply two eight-figure numbers in less than one minute.

What is most surprising about this greatest mental calculator on record is that he was stupid in mathematics. Petersen is said to have tried in vain for six weeks to get the first elements of mathematics into his head, and other eminent mathematicians found that he had very little mathematical ability. Fortunately he was advised by some of the leading mathematicians of his day to turn his extraordinary ability to scientific uses instead of going around the country giving public exhibitions, a career upon which he had entered at the age of fifteen. He calculated many useful tables and was engaged on an extensive factor table at the time of his death. The ease and speed with which he could count the number of books in a case, the number of sheep in a herd, etc., was almost more surprising than his extraordinary ability as a mental calculator.

Another well-known mental calculator, having even less mathematical ability than Dase, is Buxton, who remained illiterate through life, although his father had some education. He had a wonderful memory for numbers and could call off long numbers from right to left or from left to right with equal facility. On one occasion he squared mentally a thirty-nine-figure number in *two and a half months*. He was extremely slow and in this respect resembled a negro by the name of Tom Fuller who is known as the Virginia calculator. Although entirely illiterate he was able to reduce mentally years and months to seconds and could multiply two nine-figure numbers.

Darboux has called attention to an infant prodigy. Joseph Bertrand was born in Paris in 1822 and was such a delicate child that his parents did not expect him to arrive at manhood, and hence his early education was partly neglected. At the age of four he was sick for a long time and overheard the lessons which were given his brother in the same room. He knew the letters of the alphabet, but nothing more. When he was convalescent his parents brought him a book to look at the pictures, and he relates, in his account of his childhood, that he remembers distinctly how he shocked his parents by reading the text fluently. His frightened father snatched the book from him and commanded that under no pretext should he be allowed to do any work.

The manner in which he learned elementary algebra and elementary geometry is still more extraordinary. We reproduce his own account:

"At the age of nine I had the great misfortune to lose my father, who, during the last part of his life, resided with my uncle who directed then a school preparing for l'Ecole Polytechnique. The students, the youngest of whom was twice my age, loved me very much and I was very happy in their midst. I was assiduous at their recreations and often followed them to their classes. The teachers regarded me with astonishment but paid little attention to me. The students observed that I understood the work and when a demonstration appeared difficult, the first one who noticed me would run after me, take me up in his arms, and, placing me on a chair so that I could reach the blackboard, made me repeat the demonstration."

At the age of sixteen he entered l'Ecole Polytechnique, and, as the examiner knew that he had already passed the examination for the doctor's degree in science, he gave him some very difficult questions. From one of the answers it appeared that Bertrand had never opened a table of logarithms. The examiner considered this answer an impertinence but gave him the highest grade. At l'Ecole Polytechnique Bertrand says that he was a problem for his companions. He always received the highest grades but he was ignorant of some of the simplest things. For instance, he did not know what words were called adverbs, as he had never prepared a lesson in literature or in science and no teacher had ever asked him to make any calculations of any kind.

Bertrand's extraordinary youth gave rise to many marvelous stories. Fortunately, he wrote a brief account of his early life when he was elected in 1884 to the French Academy. Hence, we have a more reliable sketch of this infant prodigy than is possible to obtain in most other cases; for instance, in the case of his countryman, Pascal. The facts that Bertrand was permanent secretary of the Academy of Sciences for more than a quarter of a century, that he is the author of many theorems relating to modern mathematical subjects, and that he lived so recently, add interest to the account of his marvelous early education.

* Abstracted from an address before the Summer School Students, University of Illinois.

RIGHT-HANDEDNESS AND LEFT-HANDEDNESS.

By [illegible] GOULD.

THERE is no reason to suspect even the most vague or far-away beginnings of [illegible] for right or left paws in animals. So long as the [illegible] feet are used for locomotion there can be no lateral differentiation of function. I have watched [illegible] squirrels that use their front paws to hold nuts, cats that strike at insects in the air or play with wounded mice, and in many other animals, but I am sure that to neither paw is preference assigned. There is thus probably no dominance of either eye in animals. Even in the monkeys and gorillas, who of all animals most use the forepaws as hands, one catches no suggestion of preferential use or superior expertness in the dextral or sinistral side.

But in the lowest human savages all over the world choice or greater expertness of one hand is as clearly present as in civilized cases. No savages, however, are so near animal conditions as to exhibit its differentiating origins. Fixed in all our military and social customs and living at the base of language itself are two facts which solve the riddle and make clear whence and how right-handedness arose. In all tribes and countries since man used implements of offense and defense, the sinistral or cardiac side was protected by the shield, and the sinistral hand was called the shield hand, as the dextral was called the spear hand.

Next to fighting and synchronous with it was the need of barter, and the fundamental condition of bartering was counting with the low numbers, one to ten. The fingers of the free or dextral hand were, of course, first used and all fingers are to-day called digits, as are the figures themselves, and the basis of our numberings is the decimal or ten-fingered system. The tally stick, notched or numbered, is the record of the digits held in the air. Every drill and action of the soldier, from Xenophon to West Point, is dextral in every detail. The dominancy of the right eye is shown in firing from the right shoulder and sighting with the right eye. I have two patients, left-handed in every respect, who have been taught to fire their guns from the right shoulder, but of course they are left-eyed, and they depress the right eye below the level of the gun and sight with the dominant left eye.

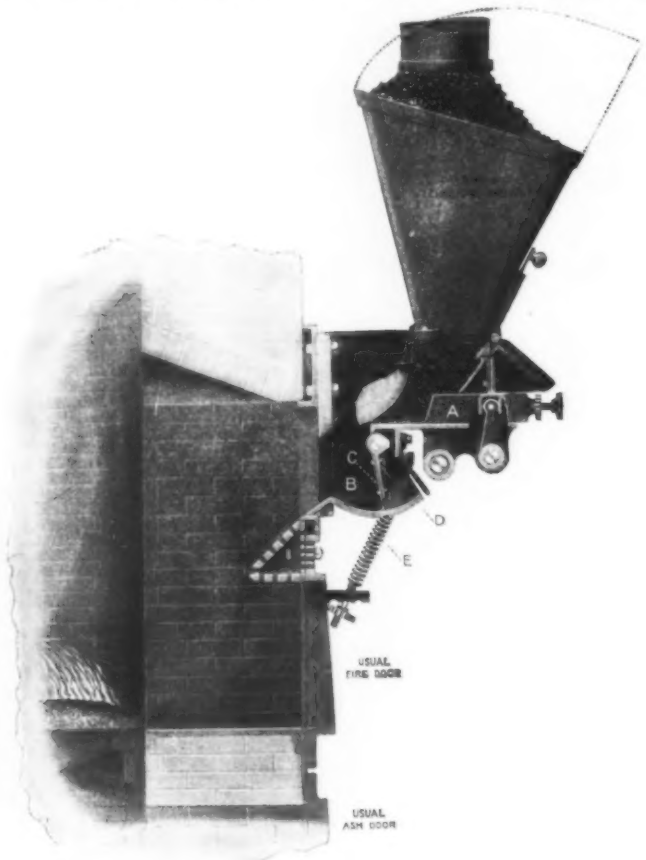
Right-footedness, less differentiated of course, must follow right-handedness, so that all soldiers must step off with the left foot first, i. e., the spring must be made with the right. The loss of the right hand, or right eye, mutilations, etc., very common in barbaric times, would help to account for the preservation of the present four per cent of left-handed people.—Medical Record.

A MECHANICAL SHOVEL FOR BOILERS.

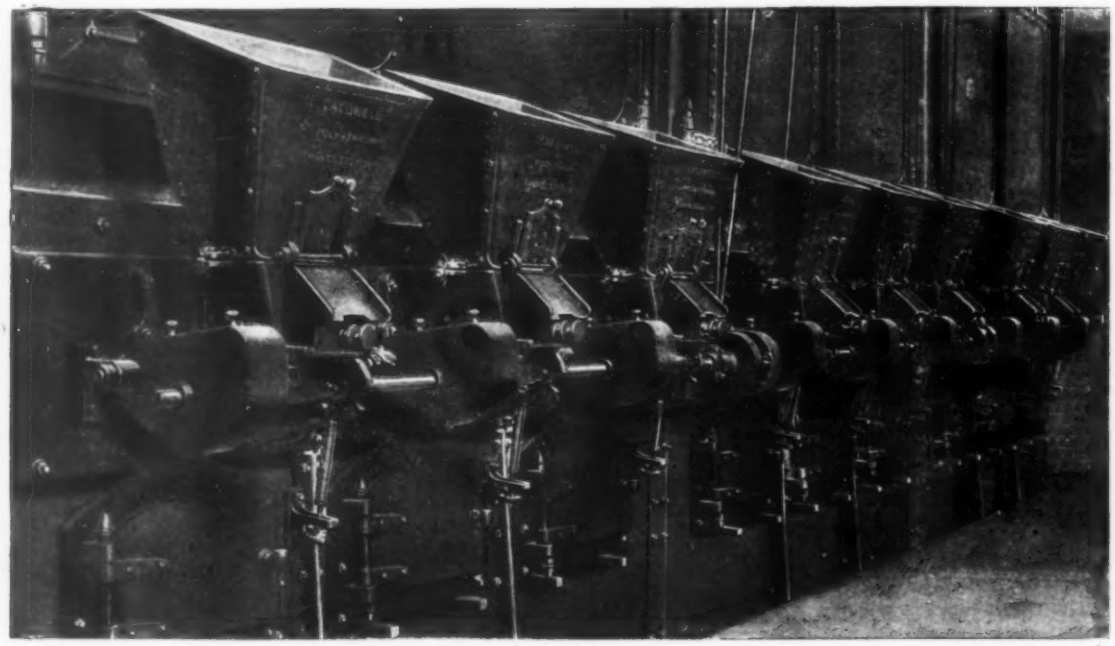
A DEVICE WHICH RAPIDLY AND AUTOMATICALLY COVERS A FIRE WITHOUT OPENING A DOOR.

THE problem of the boiler fire is one which has vexed engineers since steam was first utilized. The thick clouds—very wasteful and theoretically needless—which overhang so many a factory town are eloquent testimony to the limitations of modern inventive genius. After years of effort on the part of engineers the problem of perfect combustion still eludes them.

Perfect combustion means lessened coal and light bills, and savings in other ways; but still the expense goes on. If we could have perfect firing the problem would be largely solved. Many attempts have been made to supplant hand firing with mechanical stoking, with more or less success. Many of the stokers have needed special fire grates, or have been limited to a certain size of coal, or in other ways have been compromises between hand stoking and ideal efficiency One of the most recent of automatic stokers seems likely to be free from many of these limitations and is worthy of careful notice. Its inventors have confined themselves to the fundamental fact that a perfect firing is one where the coal is fed in small amounts, at frequent intervals, and evenly distributed over the burning surface. In the Caldwell automatic coal shovel, this need appears to be met, simply and adequately. It is in effect a sprayer, gradually working over the whole burning surface with a fine spray of coal. The mechanism is simple; a reciprocating ram (*A*) in the bottom of the coal hopper pushes a small quantity of coal (*B*) into a curved pan (*D*), in which a shovel swings, fitting the pan bottom. The shovel is drawn back by a cam and tappet to a point of release, when it returns swiftly forward under the pull of a strong spiral spring (*E*), and throws the load of coal which is on the curved pan, in a fine spray over the fire. A stronger degree of tension is automatically given to the spring after each throw, and the coal is thrown correspondingly further up the grate. Each degree of tension, and the return from greatest to least tension, are automatically adjusted. An ideal hand firer is one who feeds his fires very often and very light, and has his fire door opened as little as possible. This Caldwell shovel may be set to feed less than a pound of coal at each shovelful, and rapidly and automatically cover the entire fire surface without opening any door. Such a method of feed should give perfect, smokeless combustion, and go far toward solving the vexed problem of the boiler house.



THE WORKING MECHANISM OF THE CALDWELL MECHANICAL SHOVEL.



A BATTERY OF THE SHOVELS IN USE.

GAS ENGINE CYLINDER TEMPERATURES.

IF there is one subject more than another in connection with the thermo-dynamics of the gas engine which continues to attract the attention of investigators, it is the measurement with precision of the temperatures which occur inside the cylinder during the combustion and expansion of the gases. Much—theoretically much, that is—hangs upon these temperatures being known, and every serious attempt to measure them deserves particular attention. The latest experiments have been made by Profs. Calendar and Dalby, who very recently presented an exhaustive paper on the subject to the Royal Society. We shall in an early issue reprint the greater part of it, and it is sufficient at present to remark that the authors have endeavored only to measure the temperature at a certain point in the cycle, and that they withdraw the pyrometric wire during the rest of the time. During the explosion it is not exposed, and thus a very fine wire can be used with safety. This is a method of measurement which promises to be of great practical importance. We hope, however, it may only be a stepping stone to the development of a direct means of measuring the maximum temperature in the whole gas engine cycle—that is, not merely inferring it from a direct measurement of a lower temperature, such as the temperature of the charge at the moment compression begins; which is what is usually called the "suction" temperature. It is true that on the assumptions that no dissociation takes place, and that the specific heat of the products of combustion is constant, the temperature at any point of the stroke can be easily calculated from the indicator diagram if the suction temperature is known; but our knowledge as regards dissociation is still slender, and although great strides have recently been made in determining the variation of specific heat, the law of the variation is still insufficiently determined to enable the temperature to be calculated with certainty; and lastly, the diagram itself, if taken with a pencil indicator, is open to some doubt, especially at the

higher pressures, from which the maximum temperature has to be calculated. The authors dwell on this latter difficulty, and took their diagrams with an optical manograph.

The following figures will be of some assistance in obtaining an idea of the reduction in the maximum temperature due to the increase of specific heat with temperature. In an ideal gas engine with no loss by radiation or to the jacket, the maximum temperature would under certain conditions reach 3,000 deg. Cent. abs., with constant specific heat, but with increasing specific heat, according to the latest determinations, the maximum temperature would under the same conditions only be 2,500 deg. Cent. abs. We can feel satisfied that no such temperatures occur in the cylinder of an actual engine, but as approximations it may be taken that on the constant specific heat assumption, if the maximum temperature is 2,200 deg. Cent. abs., then with increasing specific heat the temperature would be lowered to 1,900 deg. Cent. abs. The effect of dissociation would be to reduce still further this maximum temperature and to increase the temperature further down the expansion. It will be conceded, therefore, that as regards the higher temperatures in the gas engine cycle we are still very much in the dark. The great advantage of a direct method of measurement for these temperatures is evident, but the difficulties of establishing a suitable apparatus are enormous, if not impossible, with known thermometric methods. The platinum thermometer is the most promising arrangement, but if the wire is comparatively thick so as not to fuse, elaborate corrections have to be made, which bring in uncertainties as great as those existing in the results obtained by the indirect calculation method. A material with a higher melting point than platinum is therefore needed, but it must also have a definite law of variation of electrical resistance with temperature. Such a material does not appear to be known at present. Previous attempts to measure even the suction temperature with a platinum thermometer have failed because the fine wire was exposed to the maximum temperature also, and invariably fused before any reliable measurements could be made. Messrs. Callendar and Dalby's device to withdraw the wire during the period of high temperature by means of what they call a "thermometer valve" is of great ingenuity, and ought to yield valuable experimental results.

The paper is principally descriptive of the apparatus, and of a method of testing the platinum thermometer during the compression by running the gas engine by means of an electric motor. The conclusion come to is that the suction temperature can be measured to within 1 deg. Cent. The authors only give a summary of the results of a number of trials they have run, reserving further discussion until more complete data are available. In the second example the maximum temperature calculated from the measured temperature of the mixture—viz., 130 deg. Cent. at 260 deg. crank angle—is 2,500 deg. Cent. abs. The calculation is made on the assumption of constant specific heat, but if allowance had been made for increase of specific heat the calculated maximum temperature would be about 2,000 deg. Cent., and we believe the actual temperature was nearer this value than the former. In conclusion, it is interesting to note that the suction temperatures measured by the authors agree well with those obtained by the ordinary methods of calculation.—The Engineer.

NEW TYPE OF INTERNAL COMBUSTION MOTOR.

AN ENGINE WHICH WILL RUN ON KEROSENE OR CRUDE OIL.

BY H. ADDISON JOHNSTON.

SCORES of inventors have been working for years to solve the problem of the utilization of heavy crude petroleum in an internal combustion engine.

With the exception of the Diesel, all the so-called "oil engines" are in reality oil-gas engines. The oil is vaporized either before or after its introduction into the cylinder, mixed with a definite proportion of air, to form an explosive mixture, and fired after the mixture has been made.

In the true oil engine, the oil is burned without any explosive mixture being formed, and up to the present time the Diesel engine has been the sole representative of the class.

There are a number of defects inherent in the principle of operation of these oil-gas engines, which makes it impossible to satisfactorily use heavy crude oil in them for fuel. Certain constituents of all crude oils will not vaporize under the action of heat, either inside or outside of an engine cylinder, and this nonvolatile matter often amounts to a considerable percentage of the oil. This tarry residue accumulates in the vaporizing chamber, wherever it may be, and eventually clogs it up completely if not removed. If a separate vaporizing device is used, most of the tar and carbon will remain in it, but a small proportion of the oil is carried over to the cylinder, and, condensing on the walls, helps to foul them.

If the oil is introduced directly into the cylinder or combustion chamber, so much the worse. In any case the tar and carbon will have to be periodically removed to keep the system in operation. This is a very dirty and irksome piece of work, besides which, the heat value of the tar and carbon is entirely lost.

While there are a number of engines that will run fairly satisfactorily with kerosene, a great many so-called oil engines show a tendency to clog, even with this refined fuel.

One reason for the accumulation of carbon in a kerosene engine is, that all but the very lightest of petroleum products, when subjected to a high temperature, show a tendency to "crack," breaking up into carbon and the lighter hydrocarbon gases, instead of vaporizing completely.

The most of the carbon seems to be deposited on the cylinder walls.

Another defect of the oil-gas system is, that the limit of allowable compression is very low, because of the danger of pre-ignition. This danger is increased by the necessity of heating the air and oil somewhat, to make vaporization possible. Owing to this necessity for the use of low compression pressures, the thermal efficiency of these oil-gas engines is not as high as might otherwise be attained.

For the past three years, the writer has been engaged in developing a new crude oil engine, and the principles essential to the successful commercial operation of a motor of this type have been deduced from the experiments made and are here formulated:

1. The fuel must not be heated until it enters the working cylinder.
2. It must be thoroughly atomized.
3. It must be ignited immediately upon entering the cylinder.
4. The walls of the combustion chamber must be at a temperature high enough to prevent the deposition of tar from the fuel.

While it is absolutely essential that these laws be respected in designing an engine, there are certain minor points, which, as the writer has found out by sad experience, are quite worthy of consideration.

If any small passages through which the oil flows are subject to heat, they will clog. Atomized fuel cannot be conducted through tubes, as the fine drops of fuel will recombine into larger ones. If the atomized fuel can be burned before it strikes the cylinder walls, the best results will be obtained.

In further explanation of these statements I will say:

(1.) That as long as the oil is not heated, it remains perfectly fluid and will not clog the finest holes. I have used spraying devices with holes only 3/100 inch in diameter in them; but in no case has a sprayer ever been clogged.

(2.) In experiments extending over the best part of three years, hundreds of spraying devices have been tried, and it has been found that the mean effective pressure obtained in an engine is entirely dependent upon the degree of fineness to which the fuel is broken up, all other things being equal. A poor spraying device will not only lower the M.E.P., but will cause the exhaust to be dirty and waste the fuel. With the perfected sprayer now used, the exhaust is quite clean and colorless, even when running on heavy black fuel oil.

(3.) If the oil is not ignited immediately upon entering the cylinder, the spray will have time to settle and to reach the walls of the cylinder or combustion chamber. The best results are to be had when the oil is fired as it enters the cylinder; each minute particle of oil is then surrounded by sufficient air to burn it, and it matters not what the constituents of the fuel are, as the conditions are such that tar, carbon, or anything else will be completely consumed.

When heavy oil is heated in a separate retort, there

AN IMPROVED TYPE OF KEROSENE OR CRUDE OIL ENGINE OF 60 HORSE-POWER FITTED WITH A COMPRESSED AIR STARTING DEVICE.

is a tarry residue left, because there is no oxygen present to combine with the carbon, and the temperature is not high enough for ignition; but when an infinitesimal particle of oil is ignited in a hot chamber of compressed air, the entire substance must be completely burned. Even if there were an unburned residue, the size of the individual particles of unburned material would be considerably under 1/1000 of an inch in diameter, and could not under any circumstances foul a cylinder.

(4.) If the walls of the combustion chamber are water-cooled, as in the ordinary type of engine, any of the small particles of fuel which strike the wall adhere to the surface, the light portions burn off or evaporate, the tar remains, and by constant repetition of the process, an accumulation of material occurs which eventually clogs the machine.

In the engine designed by the writer, no water-cooled surface is presented to the charge until a considerable period after the oil is injected and fired. The walls of the combustion chamber are arranged to be maintained at a temperature higher than that at which the oil will wet the interior surfaces, and it is found that no tar ever accumulates under these circumstances.

Any oil which may not be consumed as it enters the cylinder is believed to rebound from the hot walls of the combustion chamber, in the same manner as drops of water bounce from a hot stove lid.

As the engines are now constructed, it is believed that practically all the oil is consumed before it can reach the walls of the combustion chamber.

The use of a hot combustion chamber is still further an advantage, in that the air is raised to quite a high temperature before the oil is injected, and hence is in a better condition for combination than if it were cooler.

A number of engines have been constructed embodying these principles, ranging from 10 horse-power to 200 horse-power, and they have all proved very successful.

The first commercial engine built, a 9 x 12-inch cylinder, has been running the factory of the Johnston Oil Engine Company, Toronto, for the past two years, and a number of similar engines are now running factories in Toronto.

These engines will run on any liquid fuel that may be obtained, crude oil, fuel oil, kerosene, benzine, or gasoline, and without any change whatever in any part of the mechanism.

The oil used in Toronto is a refuse from the crude oil after the gasoline, benzine, kerosene, and paraffine wax have been extracted. The engines are guaranteed to develop 10 horse-power hours on ¾ gallon of this or any other petroleum oil. This oil can be obtained in Canada cheaper than the crude oil, and it gives no trouble in the engines. It is a dark, greenish-black color, its specific gravity is 0.875, and the flash point 170 deg. F. open test.

Samples of oil from all available sources have been tried in the engine, but in no case have there been any signs of clogging nor the necessity of making any adjustments. The oil is not prepared in any way, except to strain it through a fine sieve.

The writer will be glad to communicate with any person who wishes a test made of any particular sample of oil.

The features of the engines now being put on the Canadian market are briefly these: They run on any grade of fuel, require only three minutes' heating to start with ordinary equipment, or start instantaneously with an electric attachment. No cranking is required, the engine being started by compressed air. When once started, it will run indefinitely until stopped. Ignition troubles are unknown, and the same is the case with troubles with the carbureter or mixer. There is no clogging of any parts, and the engine always operates satisfactorily.

ARMY NIGHT SIGNALING BY ACETYLENE.*

THE NEW EQUIPMENT OF THE SIGNAL CORPS.

BY CAPT. L. D. WILDMAN

FROM the time the children of Israel were led out of bondage by the pillar of fire to guide them by night and the cloud by day, man has been looking for some means of communicating information through the darkness by means of light. The beacon light of the early days of history meant but one thing, and that one thing an alarm. This single light gradually developed into a simple code by adding more lights bearing definite relations to each other in order to give more definite information. As late as the "18th of April, 1775," when Paul Revere galloped to Boston, preliminary information was given him by the lights in the Old North Church, reading "One if by land and two if by sea."

Gradually this simple code, with its multiple fires, was developed into separate flashes from one fire by means of a blanket or other screen interposed between the source of light and the direction toward which it was intended to give the information. From this method transition was easy to a regular alphabet of signals by means of flashes only, as in the Myer code, or short flashes and prolonged beams as in the Morse code.

Modern appliances and modern instruments using electricity (from the wireless to the buzzer) have been developed to such an extent that there is no difficulty during the daylight in keeping in touch with any branch of the service, even while on the march at any of the usual rates of speed. The difficulty, however, of stretching wires or constructing new lines during the night has made some auxiliary means for night signaling as much of a necessity as it was during the civil war, when the electrical appliances were much simpler and less efficient.

Night signaling in the army and navy may be roughly divided into three classes: First, preconcerted signals by bombs or rockets which on exploding show one or three colors, red, white, or green, or these colors in combination. Such signals are used where it is inadvisable or impossible to send or obtain signalmen with a column in the field. Their action is always uncertain and the information which can be given by them is limited and contains the possibility of great error. Bombs and rockets also serve to locate the position of the force utilizing them, and the danger of the enemy reading the signals in such a limited code is extremely great.

The second method embraces electrical searchlights, used in various ways, and the Ardois system, which consists of four red and four white lamps used singly or in combination in accordance with the Myer code. Both of those systems require cumbersome electrical machinery for the purpose of generating the current and are not feasible for field work or in any situation except permanent emplacements and on shipboard.

The third method employs signal lanterns, which, by means of parabolic reflectors and screens, enable code flashes to be sent in any direction in either cipher or plain words. The oil lantern has so limited a range that it may be neglected, and we have therefore become practically dependent for night signaling upon the acetylene lantern. This has a range of from fifteen to thirty miles on a clear dark night, is compact and easily carried, and practically free from the objections inherent in the other methods, besides being free from danger.

Two types of acetylene lights are used in the army of the United States, the station and field lantern, differing from each other only in their range and in the method of the generation of the gas. Both lanterns are built upon specifications issued from the office of the Chief Signal Officer of the army, and are the result of much experiment by the officers of the Signal Corps and the manufacturers of such apparatus.

Since the commercial introduction of calcium carbide there have been numerous controversies by those engaged in the exploitation of acetylene apparatus concerning the superiority of the carbide-feed over the water-feed system, and *vice versa*.

In the water-feed apparatus it is well known that under certain circumstances the heat generated by the chemical change, if unabsorbed by a considerable volume of water, breaks the acetylene into a number of other gases which have less actinic power and cause some trouble by clogging the flame. On the other hand, where there is a large volume of water into which the carbide is fed, by the immersing of a basket or the dropping of granulated carbide, the heat generated is absorbed by the water and less trouble is experienced with the flame itself. Unfortunately, however, this considerable body of water with its accompanying receptacle is not always convenient, nor is it necessary where the amount of gas is small and the time during which it is burned is not great.

For semi-permanent stations, therefore, the station lantern employs the carbide-feed system, and for actual field work the water-feed system is used with equally satisfactory results. It is probably unnecessary to explain the exact method of generation in either case, as either system differs in no way from commercial systems employing the same methods.

A number of conveniences have grown up for army use, however, which are not present with ordinary commercial systems. The most important of these is the carbide cartridge for convenience and safety in shipping by rail or water and actually in the field. These cartridges consist of tin cylinders having openings at either end temporarily sealed by a strip of tin and soft solder. A small cylinder of wire mesh extends from and connects these openings with the carbide lying around the mesh on the inside of the cartridge. A rubber plug fits into the upper opening when in use, connecting with the filter. The other tube fits into the lower opening.

In actual use the sealed strips of tin are ripped off and the cartridge inserted into the generator with spring slips and the entire case closed with the gas outlet unopened. When everything is ready, this outlet valve is opened, and water has access to the cartridge until the pressure is such that the water is driven back into the reservoir. These cartridges will supply gas with the full light turned on for one hour, which gives approximately three hours of signaling power. As the slacking of carbide occurs within the cartridge, no cleaning is necessary before inserting a new one, and the change takes very little time, fresh water being introduced every time a new cartridge is placed in the generator.

In using the acetylene lantern, to get flashes, a key very much like a telegraph key is employed, which operates a valve in the supply pipe. A small screw in this valve regulates the gas when the key is at its extreme height, so that the flame is practically turned down to its lowest limits. When the key is depressed the valve opens and the full amount of gas is allowed to reach the burner, which then burns at its brightest as long as the key is depressed. When the key is again raised, the flame is reduced to the minimum. Such a key can be worked with great rapidity, and for a short distance a high signaling speed may be maintained. The longer the range the greater will have to be the difference in time between flashes, which cuts down the sending speed to a certain limit.

With the naked eye these field lanterns have been read ten miles, and with a seven-power telescope thirty miles. The flame itself is placed in the focus of a special aplanatic lens five inches in diameter with a three-inch base, so that its beam is nearly horizontal, the front of the lantern being made of strips of plain glass which merely serve as protectors.

If the signal key is broken or fails to work for any reason, a heliograph shutter may be placed in front of the lantern and used in exactly the same manner as though the lantern were the mirror of a heliograph. In strong wind the pilot flame has to be increased in size over what would naturally be the case on a calm night.

The station burner has four one-half-foot acetylene burners placed in front of a plano convex lens 5 inches in diameter with a 6-inch focus, with the center of the cluster in the exact focus of the lens. In the back of the lamp, opposite the lens, is a concave spherical mirror, with its center of curvature in the center of the cluster of flame. This arrangement gives the utmost concentration possible for throwing a parallel beam of light consistent with the size of the apparatus. On the top of the lamp is mounted a telescopic slide with adjustable disks for the purpose of accurately directing the beam. Horizontal and vertical adjustment is provided for in this station lantern, clamped by a thumbscrew, when position has been obtained, the whole being mounted on a tripod from which the generator hangs by hooks. A small reading lamp supplied from the same generator that supplies the flash lamp is mounted on the station lantern, hidden from the station with which communication is desired.

In this lantern the carbide is in granular form, held in a conical-shaped hopper above the water. There is a plug on the end of a rod which descends when the key is opened, allowing a little carbide to fall in the water beneath. The gas, which is instantly generated, again raises this plug, closing the hole in the hopper, which prevents further dropping of the carbide until the gas which has thus been generated passes out through the filter to the burners. When this gas so escapes the diaphragm connected with the key descends either by gravity, or by the key, the plug is again re-

* Paper read before the International Acetylene Association.

moved from the hole and this sequence is constantly and automatically repeated. This generator is large enough to supply acetylene for about five hours of continuous signaling. The water tank holds one gallon of water and the hopper one pound of carbide, so that the gas generated is dry and comparatively cool, the temperature being never higher than 130 deg. F.

Filters are provided and a small reservoir from which project two gas cocks, one of which supplies the signal lantern and the other the reading lamp. The signals are made by a key in the same way described in the small field lantern, the pilot flame being fed by the gas which passes through an adjustable by-pass, which may be regulated to any size desired.

Salt water can be used in this generator when necessary. In the apparatus as furnished for either lantern extra nipples, screwdrivers, washers, rubber plugs, and keys are provided.

In actual practice these lanterns are all that could be desired for the purpose used, and the adjustments are so simple that they may be taught to a soldier with the ordinary amount of common sense in one or two hours, and may be operated by either the Morse or the Myer code. In the Philippine Islands two station lanterns did all the telegraphic work between the islands of Bohol and Negros for many months across a strait eighteen miles wide. During the rainy season this was the only means of communication, as the heliograph in the daytime was useless. The light from these lanterns was so strong that even on a moonlight night there was no trouble with the messages even without the aid of a telescope.

Both the field and station lanterns are now part of the regular equipment of the Signal Corps, and are used to the exclusion of almost all other methods of night signaling.

BRAZING FLUXES.

FULL INSTRUCTIONS FOR MENDING CAST IRON OR FOR WELDING.

PROBABLY five out of every ten blacksmiths have done brazing of some kind at one time or other, as there are hundreds of little jobs that come into every shop that it is either impossible or impracticable to weld. Many of these are accommodation jobs, jobs brought in by friends that the smith doesn't want to turn down, as in many cases the articles cannot be replaced. Many smiths—in fact a large majority of them—patch or pin the break rather than dirty up their forge, even when a brazed job would plainly be the best way, for a forge must be thoroughly cleaned and freed of every trace of brass before it is again fit for use in welding work, and in many cases it pays to keep a small portable forge in which to do odd jobs of brazing. If gas can be procured, it makes by far the best brazing heat, and is clean, and in using it one has the advantage of being able to place his work to the best advantage and to be able to see exactly what he is doing during the brazing process. Gasoline forges are about half-way between gas and coal forges. The greatest difficulty with most gasoline forges is that they do not give enough heat for good-sized jobs.

If neither gas nor gasoline can be used, then the smith must fall back on his faithful coal forge; but in doing any kind of brazing, and especially cast iron brazing, only good clean coal can be used, and coke or charcoal if possible. For cast iron brazing the coal must be practically free of sulphur. Malleable iron is not so difficult to braze, and almost any means of heating may be used, and an ordinary flux (borax, boric acid, or anything of that nature) will cause the brass to run over it like water.

It is on malleable iron, steel, or common iron that most smiths try their luck, usually with success; but when they try to braze a piece of broken cast iron, they are "up against it." They get the right heat and apply their borax or salammoniac or whatever flux they have handy, and behold! the brass rolls up into little globules like so much mercury, and all the coaxing and patting won't make it stick except in isolated spots, and at last, in despair, the smith throws the thing on to the scrap pile to the accompaniment of words usually represented in the papers by dashes.

However, with care and the right kind of flux, cast iron is as easily brazed as the other iron.

The principal difference in brazing cast iron is that a special flux must be used, and a greater heat and a longer time are required. The special flux used is the following, which I have used for four or five years on all kinds of castings, with results all that could be expected:

Boric acid	1 pound
Pulverized chlorate of potash	4 ounces
Carbonate of iron	3 ounces

Mix this thoroughly, rolling out all the lumps, and then add two pounds of granulated yellow brass spelter. This flux must be kept perfectly dry, and I usually keep mine in a big fruit jar with the top screwed on tight, and only a little taken out as needed for immediate use.

To use this, arrange the pieces of cast iron to be brazed in such a way that they will not jar out of line during the brazing, and the break so that the brass and flux has a chance to flow down through it. Let the heat come from below, no matter what kind of forge is used. If using gas, throw the blast so that the flame will deflect upward. Heat the piece to a bright cherry red before applying the mixture. Then, using an iron rod, flattened on the end and heated red, apply the flux and brass, rubbing it along the break and working it in lightly, gradually raising the heat till the piece is nearly white. Keep applying the mixture for some time after it has begun to flow nicely, and when you are sure that the flux has flowed all through the break, shut off the fire and let it cool down slowly. Do not hurry the heat, brazing, or cooling. If you have taken care that the break was clean and free from grease in the first place, and have followed directions faithfully, you will be astonished at the strength of the brazed joint. It will not break in the same place again, but will break either some distance away or across the first fracture. You cannot tear apart a good cast iron braze.

In trying this flux for the first time, do not use too small a piece, but take a cast iron bar, say 1 inch by 1 inch by 12 inches, break in two in the middle, and experiment on that till you get used to the right heat and the action of the flux. After thoroughly testing out this you may begin on smaller articles, but remember that on very small pieces fire-brick or clay must be built up around them in order to hold in the heat, as a small piece hasn't body enough itself to properly fuse the flux.

Any number of uses can be found for cast iron brazing, and the different ways of arranging the pieces in the forge will readily suggest themselves.

This flux can be also used for welding, and makes an unusually good compound. Any first-class druggist can supply the ingredients, and if no spelter can be obtained, chop up some soft brass rod, sheet or scrap, and mix in; but remember, do not apply flux till your iron is at least cherry red; the hotter the better, just so the iron doesn't melt.

This flux was originated by me, and anyone may use it without fear of bumping into a "patented process."

For ordinary brazing, such as bicycle frames, and the like, the following flux is the best I have ever tried:

Boiling water	1 pint
Borax	1 pint

Let this dissolve thoroughly; then add two pints boric acid. No care need be taken of this flux other than to keep the dirt out of it. When using it dry, add a little water and paint the article wherever brass is wanted to flow. This should be done before heating, after heating more flux and brass is applied. Brass will follow this flux "uphill" for an inch or so. This flux, however, has no effect whatever on cast iron.

Some time when you have a little leisure, get a bar of cast iron, say two feet long, and an inch or two inches through, cut it in two in the middle, put it in the forge with the cut ends together, and heat to a nice bright heat. Then throw a big handful of chlorate of potash (pulverized) squarely on the two ends and quickly ram them together, and you will find you have done what many will say is impossible—namely, welded cast iron.

Another very interesting experiment is to put a handful of chlorate of potash on the anvil and heat an iron red hot and thrust it into the potash. There is no danger whatever in this experiment, provided there is no sulphur on the anvil.—Ethan Viall, in The Blacksmith and Wheelwright.

COATING WITH FRENCH BRONZE BY DIPPING ONLY.

THE French have always been celebrated for their work in ornamental bronze and other metals, real or imitation; and among their best-known work is that known as "French bronze." As a rule the effect is given by a suitable coating brought about on the surface of the metal by dipping, the effect being that of a colored patina, having the property of toning down the natural bareness of the metal surface.

A variety of French bronze, recently brought on the market, has a brown color very pleasing to the eye; and at any rate at present seems destined to drive out the gold bronze which has been so popular as to be rather overdone. The new surface is much cheaper to produce than gold bronze; but although it is so cheaply produced, the articles having these new surfaces at present command a fancy price.

The articles to be treated are first dipped in an acid aqueous solution of copper, as for instance copper sulphate, the result being to coat them lightly with pure metallic copper. With brass objects this preliminary treatment is essential; it is also desirable where brass articles are to be nickel-plated.

Where the article consists of a soft metal, as zinc, or an alloy of lead and antimony, it is recommended to dip first for a short time in a hot solution of cyanide of copper and potassium, that gives the required copper coating; after which it is to be dipped in an acid bath. The deposit takes about two hours. To a strong hot bath of copper sulphate in water there is added a slight amount of caustic soda or potash. If the solution is not strong enough nor hot enough, the results will not be satisfactory. Proportions recommended are 4.5 liters (1.14 gallons) of water, 1.4 kilogrammes (3.08 pounds) of copper sulphate, and 28 grammes (432 grains) of caustic soda or potash. The sulphate of copper is dissolved in hot water in an enameled vessel, over a gas flame or other source of heat, so as to let the solution boil. After solution is complete, the caustic soda or potash is slaked in a little hot water, added to the sulphate solution, and the whole vigorously stirred. If the caustic is added direct to the copper solution, without being at first slaked or dissolved, pieces of copper sulphate will be apt to remain in the solution and spoil the work.

The addition of the soda or potash to the copper solution causes a grayish deposit of hydroxide of copper, and at the same time there is formed a slight black precipitate; but if the solution be constantly stirred, this latter disappears gradually.

The solution having been prepared, the articles, first coated with copper in the acid bath, are dipped therein. In a few minutes there appears a light brown color; and if this is the shade desired, the articles can be taken out of the bath at once. But a better and darker color can be obtained by leaving five to ten minutes in the bath. As the color is slowly developed, no great facility nor experience is needed to enable one to take the articles out of the bath when the proper shade is reached.

After removing the articles from the bath, they are to be rinsed and dried. They will be found covered with a light-colored powder; they are to be brushed with a soft dry brush, which will bring out the color better. This brush may consist of soft brass wire, but hog's bristles are better, as by their use there is no danger of removing any portion of the coating. This color may be preserved by waxing the articles with a soft brush and paraffin wax, or by coating them with a matt varnish. Many of the articles in the market have in the fine lines or deeper portions a greenish color, produced by the use of chrome green in a solution of gum Arabic in water, applied with a rag, before the articles are varnished or lacquered.

ANALYSIS OF RED SEA WATER.

Analytical Figures.

		Per cent.
Total solids—		
Amount obtained by evaporation at 100 deg. C.		4.84
Inorganic substances—		
Chlorine	2.09	
Sodium	1.18	
Magnesium	0.135	
Calcium	0.052	
Sulphates (SO_4)	0.206	
Carbonates (CO_3)	0.007	
	3.670	
Other constituents and water of crystallization	1.170	
		4.840
Ammonia determinations—		
Free ammonia		0.00014
Calculated as NH_4Cl		0.00043
Albuminoid ammonia		0.00042
Calculated as albuminoids		0.00222

The free ammonia represents that which came off on distillation with a small quantity of sodium carbonate; the albuminoid ammonia that which came off on treatment of the water with 15 gm. of caustic soda and 1.6 gm. of potassium permanganate. Specific gravity at 10 deg. C., 1.027.—John B. Coppock, Chemical News.

HOUSE-REFUSE CLINKER CONCRETE

AS A BUILDING MATERIAL.

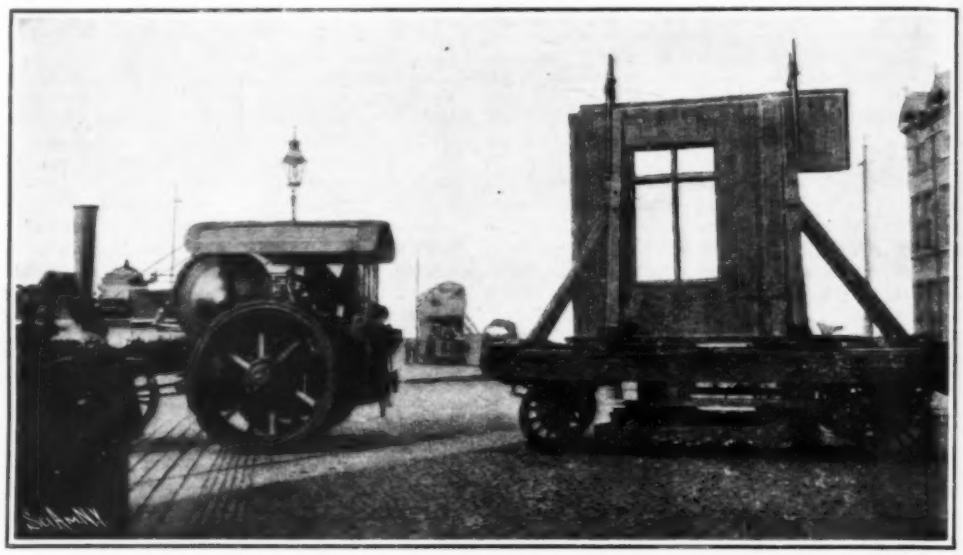
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THE possibilities of using clinker from the destructors of house refuse as a basis for concrete for house building purposes have been demonstrated by an interesting experiment in this direction by the city of Liverpool. The disposal of the clinker from the various Liverpool destructors, the production of which approximates some 50,000 tons per annum, has always been an expensive matter, since although it is extensively adopted for the manufacture of concrete slabs for sidewalks, and paving blocks for thoroughfares where the traffic is light, yet owing to the limited demands for the material in this direction—the total consumption for these purposes does not exceed 33 per cent of the total output—that which is not utilized has to be carried out to sea and dumped at a cost of about 60 cents per ton. In view of the fact that comparative tests in compression and tension with concrete blocks made from this clinker and ordinary materials respectively, demonstrated the fact that the former in each instance proved to make the stronger concrete, the city engineer, Mr. John A. Brodie, M. Inst. C. E., suggested that it should be employed in the construction of some contemplated municipal tenements. These buildings cover an area of 3,717 square feet, of which total 1,611 square feet are open space. The building is of three floors, with four tenements on each floor. Each tenement is self-contained, and the upper ones having each a separate doorway leading to a balcony extending the whole length of the building both front and back; access to the street being gained through open stairways, as shown in the accompanying illustration. The building has a flat roof surrounded by a parapet, useful either for washing or drying purposes or as a children's playground.

The building was constructed throughout in large slabs, the sidewalls being dovetailed together, and single slabs forming the floors and ceilings. These were molded at the refuse destructor works, and were allowed to mature before removal to the site. In the molding operation the various necessary spaces for windows and doors were provided. When set in position the parts were joined up with cement mortar. In order to secure accurate relation between the various sections two 1-inch bolts were introduced into each vertical joint before the cement mortar was applied, these being left in the structure and surrounded with cement.

When the designs were first prepared, a thickness of 7 inches for the walls was provided by the engineer; but in view of the experimental nature of the undertaking, the authorities stipulated that the thickness should be 14 inches, as in the case of brick buildings. In the preparation of the concrete and the subsequent molding, the ordinary methods in vogue for the manufacture of sidewalk slabs were practised, since it was not considered expedient under the circumstances to acquire mechanical labor-saving appliances. The crushed refuse clinker and cement were mixed by hand, run into the mold, and there rammed and beaten down. As a rule about three days was found to be sufficient time to permit the thinner slabs to set, and from six to eight days for the 14-inch. They were then removed and vertically stacked like timber to mature. Unfortunately, during this stage one of the supports to the stacks gave way, causing the whole consignment within to tilt over to an angle of 45 deg., with the result that a considerable number of the thinner slabs cracked, necessitating a certain amount of molding *in situ*, whereby the cost of the enterprise was appreciably increased. Some of the slabs were of large dimensions, ranging up to 16 feet long by 13 feet wide by 14 inches thick and up to 11 tons in weight.

Great care had to be exercised in the transport of the slabs to the point of erection, severe vibrations and violent jars while passing through the thoroughfares being skillfully avoided. The slabs were transported in a vertical position, stayed and braced on a trolley hauled by a steam tractor. At the building site the slabs were transferred from the conveyance, and set into position by means of a gantry crane. It may be mentioned that all slabs intended for flooring purposes were fully tested before transport to the building, a weight of 4 tons being superimposed.

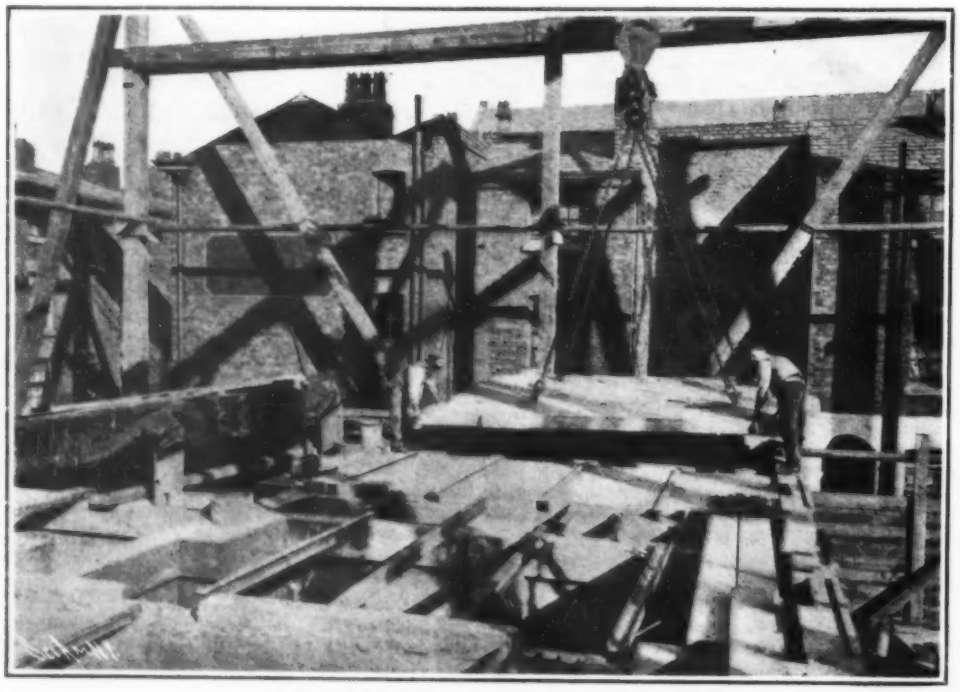


TRANSPORTING AN 11-TON WALL SECTION FROM THE DESTRUCTOR TO THE BUILDING SITE.

Despite the many drawbacks which were encountered in respect of the slabs which had been broken in the accident to the stack, rapid progress was made in assembling the sections. At the end of a fortnight the whole of the walls for the ground floor were in position, while the building was erected and roofed in the space of three months, notwithstanding several cessations in the operations due to inclement weather, and within a further eleven weeks the building was completed throughout ready for occupation.

The whole of the floors are covered with ¾-inch boards imbedded on a hot-pitch mixture, and nailed down to scantlings imbedded in the concrete. Some of the internal doors are fitted direct into the concrete; while the flues for the chimneys and ashshoots are lined with earthenware pipes. Various materials for the internal decoration of the walls were tried, some being plastered and papered, while others were simply given a coating of sanitary wash or lime. It was found that the most satisfactory medium for such tenements inhabited by the poorer classes was distemper, it being more hygienic and economical, while furthermore it can be more easily and readily cleansed with a hose in cases of infection. At the same time the surface and nature of the walls is preserved and no refuge is offered for vermin. It was found that heavy petroleum oil does not constitute the most satisfactory medium for coating the molds to facilitate the removal of the heavy slabs when intended for such purposes as these, as in some instances the oil set up discoloration of the decorated surface of the walls within the rooms.

The total cost of the undertaking aggregated $20,360 inclusive of plant, as compared with the original estimate of $6,150 made by the engineer, but this excess was largely due to unforeseen circumstances, including the added expense due to the increase of the thickness of walls by 100 per cent. Had mechanical appliances been requisitioned in preparing the slabs, and the work been carried out upon a more extensive scale, the outlay would have been brought to about the figure estimated by the engineer. But this being purely an experimental enterprise, and the first of its type undertaken in the country, many novel points rose, which tended to increase the cost of production. The experience that has been gained, however, has convinced the engineer that there is a great possibility for the utilization of such refuse clinker concrete for building operations, and that the buildings so constructed are excellently adapted to the housing of the poorer classes in large cities. The principle of construction adopted together with the nature of the material employed lends itself to the erection of handsome and perfectly hygienic buildings. Experience has also demonstrated the fact that 7 inches is ample thickness for the walls in such structures and that any desired degree of external embellishment can be easily and economically obtained. In future edifices of this nature great care would be exercised in the planning of the building so as to facilitate as much as possible the use of slabs of standard dimensions, thereby permitting duplication in the molding. In future structures the engineer estimates that the work could be carried out at a cost 25 per cent less

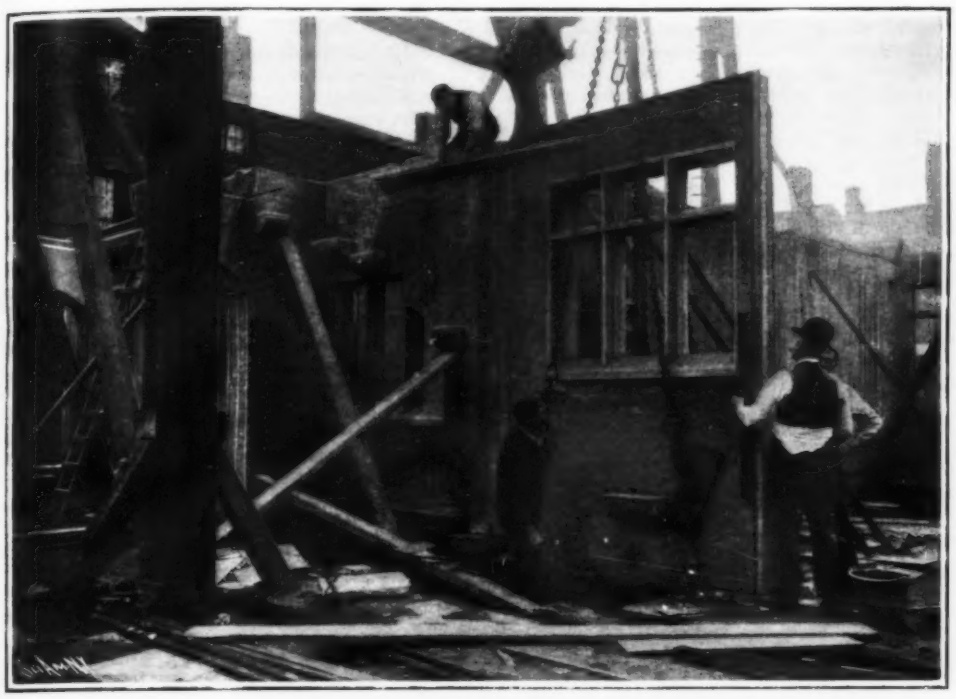


LOWERING A FLOOR SLAB INTO POSITION.

HOUSE-REFUSE CLINKER CONCRETE AS A BUILDING MATERIAL.

than execution in brick, the total outlay per block similar to this in Eldon Street aggregating no more than $8,500, provided that five blocks of a similar type were erected at one time.

One result of the Liverpool experiment has been to arouse attention as to the utility of such waste material for house-building purposes. It is hoped that those cities and towns which possess their own refuse



PLACING A SECTION OF SIDE WALL IN POSITION.

destructors and experience difficulty in disposing of the clinker will be able to derive considerable revenue from the sale of this residue for general building operations.

SAFEGUARDING MACHINERY.*

By W. H. BOOTH.

In Great Britain, and probably still more in Germany, the care of the workman is apt to be more rigid on the part of the government than it is in perhaps any other countries. In the opinion of many people who have watched the statistics of accidents, the effect of this care has been largely nullified in Great Britain by the countervailing influence of the Employers' Liability Act, which provides compensation for a workman, irrespective of whether the accident was due to his own willful disobedience of safety rules or not. It may seem curious that personal injuries should increase as a result of certain compensation. It can scarcely be believed that any man would willfully injure himself, and one can only attribute such increase of injuries to the unconscious effects of the acts for compensation.

But it is certain that workmen do take extraordinary risks without being called on to do so. Often one may hear an employer blamed because some poor fellow has gone home crippled, in order to put gold into his employer's pocket; but, careless as some employers may be, it is true that the workers are more often to blame than their employer. Men will dip under a suspended weight to save an extra yard in going round it. They will risk their own lives and their employer's solvency for the sake of a trivial economy of time.

The writer was once forced to lower a weight with tackle not safe for half the load put upon it. All hands were called clear, and the extreme danger pointed out, and yet men would pass beneath the load in this dangerous condition, and it was useless to attempt to stop them. If every one were to detail his experiences of carelessness, it would seem that some men cannot be trusted to care for their own lives or for those of others. They do not mean to be hurt; they simply think it will be all right this time, and probably say to themselves "For the last time," resolving not to do it again, and they do this once too often.

Among the inspectors of the Home Office, which is the department of the English government that cares for these things, nothing is left to chance. Often more is enforced than ought to be, for one is sometimes compelled to place fences so that they add to the danger, as when placed too near to a small gas engine fly-wheel, so that it is difficult to start the engine by the usual method for small engines, namely, by turning of the fly-wheel. Probably, in time, no gas engine will be allowed to be started except by an accumulated air pressure. Wheels are guarded very completely. A pair guarded only on their top or in-running sides were ordered to be fully cased in because "some time it might happen" that in some extraordinary way they would turn the other way round.

Machinery fencing is of two sorts. There is the guard over the pair of wheels or other detail, and there is the general guard or fence or cage which contains the whole machine and prevents all access to it except by key. Some things cannot be guarded, such as the cutters of certain wood-working machinery, and these are perhaps the worst things for accident producing, for they are almost invisible when most dangerous.

A circular saw might very often be better caged than guarded, but a saw may be very considerably protected by a distance guard, when it is impossible to guard by a close cover. The Home Office takes account also of child labor, of overtime for women and young persons generally, of heating, lighting, ventilation, and sanitation, and especially of the precautions to be adopted when persons are employed as in the glazing of pottery. All pottery people are on the *qui vive* to find a leadless glaze. One hears of leadless glaze, but investigation generally reveals a hidden source of lead. The trouble comes in the putting on of the glaze in solution, and all the evils of lead poisoning accrue, so that a strict watch is kept on all who are employed in respect of medical examination for detecting the first symptoms. Yet people who know they have symptoms will endeavor to hide them, and pass the doctor. Fans, for removal of dust, and all manner of respirators and other safeguards are more or less attended to by Home Office inspectors.

In the pottery trade, the scheme was tried of putting hoods over the heads of the workers, into which fresh air from an absolutely pure source was brought, so that there should always be a draft away from the workers and lead fumes could not get toward them, but somehow this did not answer. The lead taken into the system is not all taken through the lungs. The file cutter who cuts his files upon a block of lead is often careless how he eats food with leaded fingers, and lead will get into the body through the skin.

Copper poisoning does not appear to attract the same attention as lead, but undoubtedly brass workers suffer in health as a result of the copper. A brass founder never has any infectious complaint, it is said, for copper fumes are fatal to germ life, and, finally, are fatal to the man, but the effects are not so painful as those of lead, possibly because the copper salts are soluble and are eliminated, whereas lead accumulates. Brass workers appear to develop a dislike to fresh air. They will not put up with open windows that other men can enjoy, so that a brass shop ought to be fitted with a ventilation system out of the control of the occupants, and should be suitably warmed to fit the enfeebled workers, who might then be much improved.

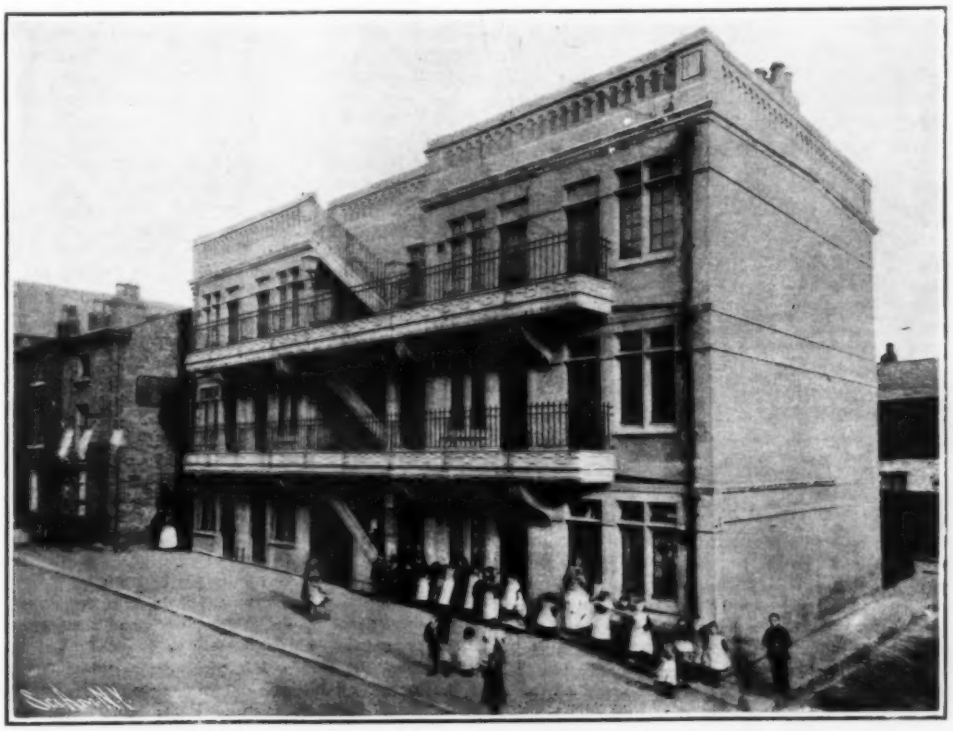
One of the reasons why Kaffir labor becomes so scarce in the Transvaal mines was alleged to be the extraordinary high pay given to the "boys" during the war. But probably a much more potent cause has been the discovery by the Kaffirs that working rock drills produces miner's phthisis, so that the men died like flies, and now fight shy of mining work. The drills ought to work through an exhausted hood piece, the dusty air being delivered through a water box to settle out the grit. The provision of good water has been shown to be a great help in keeping machinery going. Good air is equally valuable.

Every industry has its own peculiar crop of accidents, from unexpected directions and least suspected causes. It almost seems necessary for accidents to happen in order that weak points in design may be shown up, just as the true stresses in machinery and structural work only show up in actual work, though this is less the case now than formerly when the failure of bridge details began to teach men that they could not allow the same nominal unit stresses in all details, but must take account of the manner of approach of the stress-producing agent or load.

Familiarity may lead to accident. It may also serve to prevent accident. Thus, if the people of England began to-morrow to walk upon the tracks of a railroad in the way usual in America, many thousands would be killed. In a week's time very few would be even hurt. So it is with ordinary machinery. The worker does not get hurt so often as might be thought likely, but, nevertheless, he does sometimes suffer from lack of guards to the more dangerous parts. The knowledge of what to guard, and how to guard it, is quite a special knowledge, demanding acquaintance with the machine and the method of its operation, and a general acquaintance with machinery and with accidents of all kinds.

* In Machinery.

Laying Powder for Hens.—Oxide of iron, 50 parts; precipitated chalk, 200 parts; powdered ginger root, 100 parts; phosphate of lime, 100 parts. The large proportion of chalk is necessary for the formation of the egg shells.



A COMPLETED LIVERPOOL TENEMENT: BUILT OF HOUSE-REFUSE CLINKER CONCRETE.

HOUSE-REFUSE CLINKER CONCRETE AS A BUILDING MATERIAL.

HIGH EXPLOSIVES.*

THE COMPOSITION OF MODERN POWDERS.

BY AUGUSTUS KLOCK.

THE chemistry of explosives involves some of the most important laws and principles of chemistry. We deal, for the most part, with substances that are endothermous with respect to the products of their decomposition, these products being, in the most effective explosives, gases that are invisible.

"An explosion takes place when by some mechanical or chemical agency a body is suddenly converted into the gaseous state; the quantity of heat, the quantity of gases developed, and the time within which this takes place, determine the force of the explosion. An explosive is, therefore, a body that possesses the property of liberating suddenly large quantities of gas and heat and by their action is capable of performing work."

Explosives are divided into two groups:

1. Low explosives; directly exploding materials such as gunpowder.

2. High explosives; indirectly exploding substances such as guncotton, the highest effect of which is produced by the use of an intermediate body called a detonator.

The pressure of a given quantity of gas is, according to Gay Lussac's law, proportional to its absolute temperature. The greater, therefore, the amount of heat that is generated in a certain quantity of gas, the higher will the pressure of the gas become. The heat produced during the explosion can, consequently, be taken as a measure of the theoretical strength of an explosive. The duration of explosion becomes a most important factor in this last consideration, because the shorter the time in which the explosion takes place (in other words, the shorter the time which the body takes to turn completely into gas), the more heat remains to augment the pressure of the gas.

The speed of explosion for different explosives runs about as follows:

A kilogramme cube of gunpowder, 1/100 second.
A kilogramme cube of dynamite, 1/50000 second.
A kilogramme cube of guncotton, 1/50000 second.

When it is remembered that in the above 1/50000 of a second, a high explosive like nitroglycerin (the essential constituent of dynamite) forms a volume of gas that at the very high temperature of the explosion tends to occupy a volume nearly 20,000 times the original volume, one can more easily understand the tremendous effect produced by such an explosive.

GUNPOWDER OR BLACK POWDER.

Gunpowder is supposed to have been invented by the Chinese; but Guttman, one of the best authorities on its history, concludes it is rather certain that the Chinese did not invent it. It undoubtedly had its origin in Greek fire which was used in the Orient as early as the year 711 A. D. This Greek fire had practically the same composition as gunpowder. The following percentages of the constituents in each will indicate the similarity.

According to Marcus Græcus,

	Greek Fire.	Modern Gunpowder.
Sulphur	11	10
Carbon	22	16
Saltpeter	67	74

The method of manufacture of black powder, its properties and forms, are so familiar to every chemistry teacher that they are omitted here. It is well, however, to review the fact that the reaction for explosion of confined gunpowder is very different from that of gunpowder exploded in the open. The reaction for the unconfined explosion is represented by $2KNO_3 + 3C + S = 3CO_2 + N_2 + K_2S$. While the reaction of the explosion confined as in a gun barrel is represented by: $16KNO_3 + 21C + 5S = 5K_2CO_3 + 13CO_2 + K_2CO_3 + 3CO + 2K_2S_2 + 8N_2$. These equations express the quantitative relation between the powder constituents and the products of explosion.

GUNCOTTON.

Guncotton is a typical high explosive. "The manufacture of guncotton and of nearly all nitro-compounds consists essentially in immersing a prime material (cotton, glycerin, and similar materials) in a mixture of nitric and sulphuric acids and allowing the nitric acid to act upon it for a more or less prolonged time. The explosive body thus formed is then separated from the spent acid and washed very thoroughly."

The equation for the reaction of formation of guncotton is: $C_{12}H_{20}O_{10} + 6HNO_3 = C_{12}H_{14}O_4(O.NO_2)_6 + 6H_2O$.

From this we see that six atoms of hydrogen have been replaced by six nitro-groups (NO_2), six molecules of water being formed at the same time.

In order to prepare a nitro-compound it would seem from the above reaction that nitric acid only was necessary for the nitration. It will be seen, however, that water is formed at the same time and this would constantly dilute the concentrated nitric acid necessary to the reaction. Sulphuric acid is, therefore, added in considerable quantity, the purpose of which is solely to take up the water formed by the reaction and thus maintain the high concentration of the nitric acid. Guncotton was invented by Schönbein in 1846. He used a mixed acid consisting of 75 per cent concentrated sulphuric acid and 25 per cent concentrated nitric acid, the specific gravities of which were 1.84 and 1.45 respectively, practically the same as that of the concentrated acids of our laboratories. This mixed acid is a drastic liquid, difficult to handle, giving off troublesome fumes.

The cotton used for making guncotton is from three sources:

1. Cotton from the pod.
2. The so-called "shoddy" cotton.
3. The "cop-waste" from cotton spinning or the clippings from knitting mills.

The last source is the most important. This, being at first covered with grease, is given a thorough boiling in caustic soda (9 hours). The alkali is then drawn off and the cotton is boiled in water (8 hours). It is then washed in a centrifugal machine, thus removing most of the water; finally it is placed on a wire netting and dried until it contains less than one-half of one per cent of moisture. Usually, before the final drying, the cotton is run through a picking machine that straightens out the tangled mass of cotton and opens up the knots and rolls. After the picking the cotton is of fine loose quality. The cotton is now nitrated either in dipping pots or centrifugals. A centrifugal for this purpose has a perforated wrought iron basket, about three feet in diameter, that revolves within a cast iron case; a discharge pipe operated by an exhauster carries away the fumes formed in the process. The mixed acid is poured into the centrifugal until it is nearly full. Then the cotton (about 20 pounds) is put in through a hole in the top of the case. The nitration then proceeds and is finished in about thirty minutes.

The spent acid is now drawn off, the cover closed, and the centrifugal is set revolving rapidly to wring out most of the remaining acid.

The guncotton, as wrung out by the centrifugal, is now removed from the centrifugal machine with iron forks, generally scissors-shaped, and placed in a washing machine called a beater. This has paddle wheels to stir the cotton as a steady stream of water flows through the machine. This treatment is continued until the cotton will not redden litmus paper.

The guncotton still, however, contains acid, especially within its tubular fibers that have maintained the structure of the cotton. To eliminate this acid, it is boiled in a two per cent sodium carbonate solution for eight hours. In the early days of guncotton it was assumed that guncotton is entirely free from acid at this stage; but as a matter of fact it is not, and many serious explosions, due to decomposition brought on by the presence of acid, taught the early experimenters that further treatment is necessary. Nowadays, therefore, the guncotton, after its boiling in sodium carbonate, is put into a pulping machine, or "rag engine," which tears the threads into fine bits. Next it is thoroughly washed in a poacher and often is afterward treated with limewater, precipitated calcium carbonate, and sodium hydroxide, all in small quantities. For military purposes this guncotton is now pressed into cakes by molding machines under tremendous hydraulic pressure. The guncotton as kept and stored contains at least 20 per cent of moisture, for in this condition it will explode (when detonated) with the same violence as when dry, and it is then safe from fire and safe to transport.

Properties of guncotton: Insoluble in water, alcohol, or ether; soluble in acetone or benzol; resembles ordinary cotton but is harsher to the feel; not readily exploded by shocks but violently so when detonated. Its price is about one dollar per pound.

The formula for cellulose has long been doubtful. The first supposed formula was $C_6H_{10}O_5$; this when fully nitrated would give tri-nitro-cellulose, and the next lower di-nitro-cellulose. Eder found, however, several nitro-compounds in which the percentage of nitrogen was between that of tri-nitro-cellulose and di-nitro-cellulose. He therefore doubled the formula for cellulose to $C_{12}H_{20}O_{10}$, and while some experimenters have suggested still higher values, this formula seems most generally accepted. Eder produced five different kinds of nitro-cellulose as follows:

	Per cent.	
$C_{12}H_{14}O_4(O.NO_2)_6$ Hexa-nitro-cellulose,	14.14 N.	Guncotton.
$C_{12}H_{15}O_5(O.NO_2)_5$ Penta-nitro-cellulose,	13.75 N.	
$C_{12}H_{16}O_6(O.NO_2)_4$ Tetra-nitro-cellulose,	11.11 N.	Collodion
$C_{12}H_{17}O_7(O.NO_2)_3$ Tri-nitro-cellulose,	9.15 N.	Cotton.
$C_{12}H_{18}O_8(O.NO_2)_2$ Di-nitro-cellulose	6.76 N.	

The guncotton of which we have been speaking is hexa-nitro-cellulose. All the others are forms of collodion cotton, which differs from true guncotton in being soluble in mixture of ether and alcohol. Collodion cotton is called pyroxylin, and is made from cotton, nitrating with a mixed acid of proportions quite different from that used in making guncotton. The proportions are 50 per cent concentrated sulphuric acid and 50 per cent concentrated nitric acid; and the nitration is carried on for a longer time. Collodion cotton is used for making collodion, celluloid and smokeless powders.

SMOKELESS POWDERS.

These were invented in 1886. They are usually forms of nitro-cellulose (collodion cotton) treated in some way to render them slower of combustion and are less sensitive to shocks and to heat. They are as a rule less inflammable than guncotton; they contain usually no metallic salts that produce smoke. There are three classes of smokeless powders:

1. Mixtures of nitro-cellulose and nitro-glycerin.
2. Those consisting of nitro-cellulose mainly.
3. Those consisting of the nitro-derivatives of the hydrocarbons.

NITRO-GLYCERIN.

This is a nitric ether of glycerin and not a nitro-compound as its name would suggest. Since glycerin is a tri-atomic alcohol, nitro-glycerin is formed by the replacement of three hydrogen atoms by three nitro-groups,

$$C_3H_5(OH)_3 + 3HNO_3 = C_3H_5(NO_3)_3 + 3H_2O.$$

"The manufacture of nitro-glycerin is guided by the same principles as that of guncotton; the sulphuric acid being used to keep the concentration of the nitric acid up to the proper degree, that is, to take up the water formed during the reaction." In an additional way, the sulphuric acid helps to precipitate the nitro-glycerin, since nitro-glycerin is soluble in either concentrated nitric acid or concentrated sulphuric acid but not in a mixture of both. In nitration, it is not possible to bring the whole of the nitro-glycerin at once into the acid mixture as in the case of guncotton, because the heat developed in the reaction would raise the temperature dangerously high. On account of the viscosity of the sulphuric acid, we can not pour the mixed acid into the glycerin because a thorough mixing would not take place before the temperature of decomposition of nitro-glycerin was reached. For these reasons, the whole acid mixture is placed in a suitable vessel, and the glycerin is allowed to enter the mixture in small quantities. Nitro-glycerin was invented by Ascanio Sobrero in 1847. The glycerin used is very concentrated, specific gravity 1.26. The mixed acid used in nitration contains about 60 per cent concentrated sulphuric acid and about 40 per cent concentrated nitric acid.

The nitration is carried on in a lead vessel. A thermometer is provided to give constantly the temperature of the mixture. The glycerin is forced in under pressure through a perforated, one turn, coiled tube at the bottom of the lead vessel. The temperature is kept down by a stream of cold compressed air that continually bubbles through the mixture and stirs it. Cold water also circulates around the outside. The temperature is never allowed to go above 20 deg. C. The time of nitration is about thirty minutes.

After nitration, the mixed acid and nitro-glycerin is allowed to run to the separating house where the nitro-glycerin separates from the heavier mixed acid by floating on its surface. Once separated, the nitro-glycerin is allowed to run to another building, the neutralizing house, where the acid that still clings to the nitro-glycerin is neutralized by a sodium carbonate solution. After this neutralization, it is washed thoroughly with water and separated from the water. In this condition it will keep safely for years.

Pure nitro-glycerin is a water-white liquid. Its specific gravity is 1.6. It is soluble in alcohol and in ether. It is almost never used directly, except in torpedoing oil wells, when it is made on the spot where

* This article is based on material gathered by the writer while in the employ of a large powder manufactory, and was read in a modified form at a recent meeting of the New England Association of Chemistry Teachers. Mr. Klock is now secretary of this association. It is here republished from School Science and Mathematics.

is to be used. Nitro-glycerin is especially important because it is the essential ingredient of dynamite.

Nobel first made use of nitro-glycerin in 1864 and he invented dynamite in 1866.

DYNAMITE.

Dynamite is simply some kind of absorbent such as wood pulp or an infusorial earth, saturated with nitro-glycerin. There are two kinds of dynamite:

1. Where the nitro-glycerin is mixed with an inactive substance like kieselguhr. In this case the absorbent is called a "dope."

2. Where the nitro-glycerin is mixed with an active absorbent like ammonium nitrate which is of itself an explosive.

In the common forms of dynamite there are a large number of substances, namely:

(a) Nitro-glycerin.

(b) The absorbent, or "dope."

(c) Ammonium nitrate or sodium nitrate.

(d) A little calcined soda to destroy possible trace of acid.

(e) Vulcanized rosin to allow for the oxygen excess in sodium nitrate or ammonium nitrate.

The rosin is vulcanized to make it granular, the ammonium nitrate is coated with vaseline to reduce the effects of deliquescence. All these substances are incorporated in a special mixing machine and the mixture transferred to paraffin paper shells possessing the familiar form of a stick of dynamite. The detonation of guncotton and of dynamite is best accomplished by a cap containing mercury fulminate, the explosion of which disrupts the molecular structure of the high explosive. If you touch a match to a dry piece of guncotton or to a quantity of nitro-glycerin, it will burn like so much red fire, that is, harmlessly, for this does not detonate it. Detonation then, and not ordinary burning, brings out the highest effect of a so-called high explosive.

In the above paper the writer has drawn many of the facts from the classic work of Guttman, "The Manufacture of Explosives," which is without doubt the most reliable work on the subject.

CATALYTIC ACTION.

A DISCUSSION IN THE LIGHT OF MODERN CHEMISTRY.

BY PROF. WILHELM OSTWALD.

THE rapidity of chemical processes varies to the uttermost limits of mensurability. In other words, some processes are so rapid and others are so slow that we cannot determine the time required for their accomplishment in either case. Here a distinction must be made. When two liquids, for example, are brought together, the reaction between them can take place only at the surface, or surfaces, of contact, and these surfaces are soon covered by products of reaction which must be removed before the reaction can proceed. Their removal is effected by diffusion and convection. Diffusion is the tendency of the ingredients of a complex fluid to distribute themselves uniformly, so that differences in the composition of the fluid at different points are followed automatically by movements of each ingredient from places where it is most abundant to places where it is least abundant. It is only through very short distances that this process can be accomplished quickly; considerable time is required for diffusion alone to produce uniformity through a single millimeter (1-25 inch). But diffusion is supplemented by convection, or mechanical mixing. By stirring and shaking, the surfaces of contact of the various ingredients are enlarged, and extended to parts of the fluid hitherto unconcerned in the reaction, so that only very small distances remain to be covered by diffusion, in order to produce uniformity. In this way the mechanical impediments to chemical action are greatly diminished.

All these things are of great practical importance, but they have no direct relation to reaction velocity in the chemical sense. In many cases the slowness of chemical reaction is shown by the fact that the mechanical equalization described above can be effected before any considerable or even measurable quantity of substance has undergone chemical change. Then the chemical process goes on slowly in the uniform mixture and its progress can be traced by following the changes in the properties of the solution. It is at this point that differences in reaction velocity become manifest. Some reactions are so rapid that they are completed before the mixture has become uniform, and some are so slow that the properties of the unaltered solution can be studied after it has been uniformly mixed, but before any appreciable chemical action has taken place. Even in these cases it must be assumed theoretically that some change has occurred. All that we can assert is that the amount of change is immeasurably small.

Very little is known in regard to the factors which determine the reaction velocity in any given case. It is certain, however, that temperature has a great influence. As a rule the reaction velocity increases very rapidly with increase of temperature, so that it is doubled by a rise of temperature of about 10 deg. C. (18 deg. F.). The only other temperature coefficient that is comparable with this is the increase of vapor tension with temperature. The coefficient next in magnitude, that of viscosity, is equivalent to a change of about 2 per cent per degree C. Reaction velocity is proportional to an exponential function of the temperature, and doubles for each 10 degrees, so that an elevation of 100 degrees C. increases the reaction value more than a thousand fold.

Reaction velocity is almost equally sensitive to certain other influences. Under similar conditions of temperature and concentration it varies very greatly according to the nature of the solvent, so that the same two substances may react violently when dissolved in one medium and show no change for days when dissolved in another. Here, too, little definite is known, except that solvents which contain oxygen commonly determine more rapid reactions than solvents free from oxygen.

Finally, there are many substances which strongly affect the velocity of reaction when they are added to the mixture, even in very small quantities. In most cases these substances may be said to take no part in the reaction, in the sense that they are found unchanged, in practically undiminished quantities, after the termination of the process. This statement does not exclude the possibility that they do take part in the reaction, but merely involves the assumption that after such participation they are again set free. They may, for example, form constituents of intermediate products which are subsequently decomposed.

The quantitative action of these substances, which are called catalyzers, varies between very wide limits. In some cases a great effect is produced by so small a quantity of the catalyzer that this catalytic action furnishes by far the most sensitive known method of chemical analysis. In other words, when all other methods of detecting the presence of a substance have failed, so that the specimen submitted to analysis appears to be entirely free from it, then, if the substance sought is a catalyzer, its presence may sometimes be detected by the catalyzing action of the specimen. The presence of a catalyzing agent in the proportion of one molecule in a thousand million liters has been detected in this way.

In a large majority of cases the catalytic effect consists in an acceleration of the reaction. It is not yet certain whether the retardation of reactions sometimes produced by the presence of small quantities of foreign substances is caused directly by retarding catalyzers or indirectly by the neutralization of accelerating catalyzers. At all events, acceleration is more often observed than retardation, and the number of accelerating catalyzers is very large.

Catalyzers are more or less specific. That is to say, each particular reaction is accelerated by its own special group of catalyzers. Although there are a few substances which affect various reactions, the effect cannot be ascribed to one factor dependent on the catalyzer and another factor dependent on the reaction, but is determined by influences which differ in each case and are little understood.

The preponderance of acceleration in catalysis is related to the observed fact that many substances act very slowly on each other in the condition of the greatest attainable purity. As quantities far too small to be detected by other methods may act as effective catalyzers, the theory that absolutely pure chemicals do not react together with measurable velocity, and that all observed reactions are induced by infinitesimal amounts of catalytic impurities, can neither be proved nor disproved. In general, however, differences in the rapidity of a reaction under apparently identical conditions may fairly be attributed to differences in the character or concentration of yet unknown catalyzers which have escaped detection.

Ideal Catalyzers.—The existence of catalyzers furnishes an important aid to the theoretical simplification of actual processes. Every science makes use of such idealizations—absolutely rigid solids, absolutely mobile liquids, perfect gases, absolutely black bodies, perfect insulators, reflectors, etc. None of these has any real existence, and the assumption of their existence is a conscious departure from actual conditions. These idealizations represent limits to which their real correlatives approximate more or less closely and which, by reason of the simplicity of the assumptions on which they rest, are susceptible of simple mathematical treatment. The result of the calculation is never quite accurate, but if the idealizations have been so chosen that the result approximates to the truth in proportion as the actual facts approximate to their idealizations, the result will be an equally close approximation to the truth. Furthermore, it is possible in this way to discover in which respects the actual conditions must be modified in order to bring them nearer to the ideal conditions. For example, the formula for the ideal pendulum indicates the manner in which a pendulum should be constructed in order to acquire isochronism, the most important property of the ideal pendulum, as nearly as possible.

In this sense catalyzers afford theoretical means of establishing ideal chemical conditions. By the imaginary addition of an ideal accelerator of infinite potency to a slowly reacting complex the element of time is eliminated, or in other words, the only possible conditions are conditions of equilibrium. Hence all completed reactions may be conceived as being induced by such ideal accelerators. On the other hand, the assumption of the presence of ideal retarders (or the equivalent assumption that no reaction can take place without an accelerator and that no accelerator is present) allows us to regard each stage of a progressing reaction as fixed and final. These ideals are never realized exactly, but they greatly simplify the theoretical treatment, and lead to results which approximately agree with the truth.

In all such cases, we must ask ourselves whether the assumptions violate the laws which govern the facts, and whether they consequently lead, not to limiting, but to erroneous values. Although it is not practicable to answer such a question in all its generality, it is easy to prove that the assumptions here made do not violate the most universal of all laws, the laws of energy. The conception of ideal catalyzers involves the assumption that the rapidity of chemical reactions can be varied from zero to infinity without a corresponding variation in expenditure of energy. But the physical fact of the existence of real catalyzers which cause a similar variation in reaction velocity within very wide limits, though not to infinity, proves that very great variations of reaction velocity can be effected without any expenditure of energy, and justifies the extension of the same law to ideal catalyzers.

The laws of energy determine only the final state of the mixture under given conditions, but they do not determine the time occupied in reaching this final state. In chemical, as in mechanical, electrical, thermal, and other processes, the time is influenced by many factors which are not determined exactly by the two fundamental laws of energy and which, consequently, endow the reaction velocity with a corresponding number of degrees of freedom.

This variability of reaction velocity from zero to infinity, gives a hitherto unsuspected variety to the subject matter of chemistry. Conditions of change under the operation of infinitely small reaction velocities may appear to us as conditions of equilibrium. Hence solutions and other bodies are presented for our consideration which would remain entirely unknown if all chemical processes were accomplished with infinite velocity, or with velocities too great for human observation.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prinzipien der Chemie (1907).

BELLADONNA GROWN IN AMERICA.

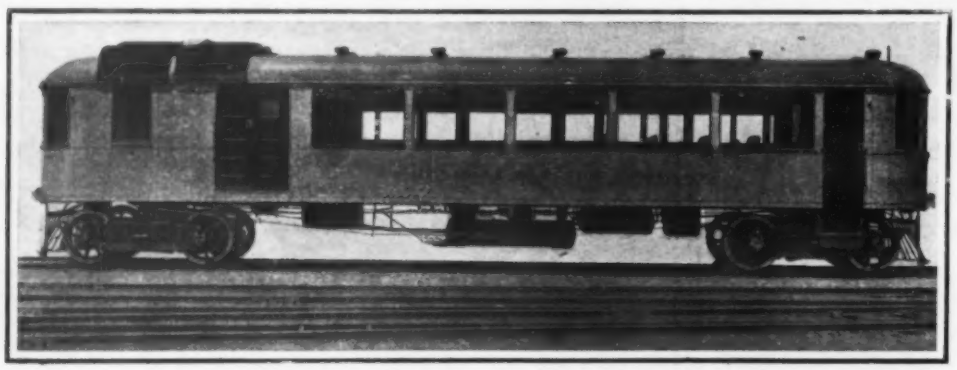
IN view of the decreasing quantity and depreciating quality of the belladonna imported into the United States a few plants have been cultivated in the Shenandoah Valley, Virginia. The dried leaves from the first year's seedlings yielded 0.32 per cent of alkaloids; the leaves from the second year's growth, gathered in July while the plants were flowering, gave 0.68 per cent. In October an average plant gave 7 ounces of dried leaves, assaying 0.48 per cent of alkaloids, and 5 ounces of dried root, assaying 0.38 per cent. Although this root is below the U. S. P. standard, it is fully equal to the bulk of the imported drug.—J. R. Reppetoe, Amer. J. Pharm.

A GAS-ELECTRIC CAR FOR RAILWAY SERVICE.

A NOVEL TYPE OF CAR FOR SUBURBAN TRAFFIC.

THE accompanying text and illustrations describe a gas-electric car which has been designed by the General Electric Company to meet railway service conditions.

The car is of the combination type, and comprises one ordinary passenger compartment, a smoking room, baggage room, engine room, toilet and observation compartment. The car is single ended, having the controlling apparatus situated in the engine room.



A CAR DRIVEN BY A GAS-ELECTRIC MOTOR.

The principal dimensions are as follows: Length over all, 50 feet; length of engine room, 9 feet 6 inches; length of baggage room, 5 feet 8 inches; length of smoker, 7 feet 11 inches; length of passenger compartment, 18 feet 6 inches; width over all, 8 feet 8 inches; height over all, 12 feet 10½ inches; seating capacity, 44; total weight of car and trucks fully equipped, 31 tons.

This car was designed throughout with special reference to the service required, the main object in view being to secure the maximum carrying capacity with a minimum weight, and at the same time to have a car of great strength. The shape of the ends is parabolic in order to reduce the air resistance to a minimum when traveling at high speed. The general shape of the car will be seen by reference to the illustration.

The gasoline engine is direct-coupled to a 90-kilowatt direct-current generator, which furnishes current at a variable potential. This current is fed to the motors through the medium of the control system by which the voltage of the generator may be governed according to the requirements. The two motors are rated at 60 horse-power.

The engine was designed and built with special reference to the requirements peculiar to gasoline electric cars. Very special attention has been paid to the simplification of the engine; the number of parts and weight have been reduced to a minimum.

When running at 550 revolutions per minute the engine develops 100 horse-power and has a greater capacity at increased speeds. There are eight cylinders, each of which is 8 inches in diameter and has a stroke of 7 inches. The cylinders are placed at 90 deg. to one another, or at an angle of 45 deg. with the vertical. Each cylinder is composed of one piece, being of very soft fine-grain cast iron. Each casting is self-contained and includes the water jacket; it is worthy of note that special attention was paid to provide an extra large cooling surface around the valves to eliminate any excessive temperature at the valve seats. There is one admission and one exhaust valve for each cylinder, both arranged in such a manner as to permit inspection by the removal of two nuts. The pistons are of the trunk type; they are made of cast iron and are rendered gas tight in the cylinders by the provision of three split piston rings. The connecting rods, made of chrome nickel steel, are connected with the pistons by means of hollow pins shrunk into the body of the connecting rods. The crank shaft is made in one forging of 40 carbon steel; it is a four-throw crank having an angle of 180 deg. All of the crank pins lie in the same plane, the two center pins occupying the same angular position while the two outside crank pins are set at 180 deg. to the center crank pins. This arrangement of cranks with cylinders set at 90 deg. to one another gives a very satisfactory system for balancing purposes. Two connecting rods are coupled to each crank pin.

BREECH BLOCK OF THE GASOLINE MOTOR.

Each cylinder is fastened to the engine base by means of six bolts. The engine base proper is made of one casting of Parsons manganese bronze, the form of which is clearly shown in the illustration. The crank casing, which is made oil-tight, is aluminium.

All of the valves, both admission and exhaust, are actuated by one cam shaft which is driven from the main engine shaft by two gear wheels with the customary 2 to 1 reduction. This cam shaft is entirely inclosed in a circular tunnel which runs the entire length of the engine base; the tunnel is formed in the main casting. The fact that the valve rods are all operated from this one shaft has greatly simplified the design of the engine.

There are two carbureters of the float feed type. The ignition system is of the high tension type; a separate coil is provided for each cylinder. These coils are energized by means of a small accumulator. The sparking at the correct instant in each cylinder is effected by means of a roller commutator.

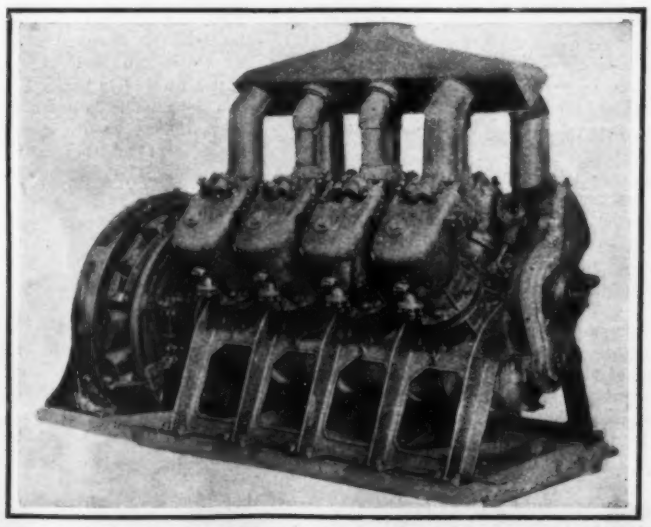
Considerable difficulty has been experienced in starting gasoline engines of this size heretofore, but in the present instance a special breech block mechanism has been provided which fires a charge of black powder into one of the cylinders, and this has proved a most effectual way of overcoming these difficulties. This piece of mechanism is illustrated by one of the illustrations.

The cooling system for the cylinders operates on a thermo-siphon principle. The radiator, which is situated on the roof of the car, is divided into four separate nests of radiating tubes. These, being of the spiral-fin pattern, give a maximum cooling area per unit length.

The total cooling surface amounts to approximately 1,300 square feet. Each pair of engine cylinders is connected to one nest of tubes and the four nests are in turn connected by means of three copper pipes. The water jackets are connected to the radiator by means of pipes running vertically from the engine; these pipes pass through the roof and the circuit is completed by means of other pipes leading from the radiator to the cylinder jackets. This system forms the most simple cooling arrangement possible, as it entirely eliminates the necessity of using pumps or cooling fans, and it has the further advantage of being easily drained and of being filled from the side of the car.

It is of interest to follow the course taken by the gasoline from the storage tank to the carbureter. The gasoline is stored beneath the car in a large steel tank having a capacity of 90 gallons, and is raised to a small auxiliary tank in the cab by means of a diaphragm pump. The gasoline is filtered in transit from the tank to the pump. The auxiliary tank is provided with a float to register the height of the gasoline, and a glass tube somewhat similar to a sight-feed lubricator is provided so that the operator can see if the diaphragm pump is working. The gasoline is fed by gravity to the carbureter.

The oiling system has been very carefully designed. Forced lubrication is used and for this purpose there is a nest of pumps operated from the main shaft. One pump is provided for each of the main bearings and another oils the cams and cam mechanisms, the duty of this latter pump being to keep the cam shaft tunnel filled with oil; the oil on leaving the tunnel flows over the reduction gears and thence to the crank chamber. All of the oil used for lubricating purposes similarly flows to the crank chamber, whence it can be drained. The big ends of the connecting rods are lubricated by scoops which dip into the oil in the bottom of the crank chamber, the oil being forced to the crank pin as the crank shaft revolves.



THE GASOLINE MOTOR DIRECT-CONNECTED TO THE GENERATOR.

The generator is a General Electric 90-kilowatt, eight-pole, separately excited unit, which has been specially designed with a view to procuring the lightest possible machine for the necessary output, and at the same time, keeping the temperature rise to within a reasonable figure. It is provided with commutating poles, which, in conjunction with the potential type of control, gives a great flexibility of current output.

The advantage of this arrangement will be readily appreciated when it is pointed out that at starting the field excitation is weak, and that large currents are required to give the necessary starting torque. The normal pressure when running at 550 revolutions per minute is 250 volts, at which time the current will amount to 360 amperes, but at starting a current of 800 amperes can be secured at a corresponding decrease in voltage. It would be impossible to commutate so large a current in a machine with so great a kilowatt capacity per pound without the use of commutating poles.

The total weight of the generator including exciter is only 2,740 pounds, while a standard machine of this output weighs 8,800 pounds. As is only natural in a machine where the weight has been so materially re-

duced, the temperature rise is higher and the efficiency lower than in standard apparatus of the same output. The higher temperatures are fully provided for by the type of insulation employed; there is no paper or muslin used anywhere in the machine. The armature coils are insulated with mica, the interpolated pole coils with asbestos and the field coils are wound with enameled wire. The armature leads to the commutator are riveted as well as soldered, although the precaution has been taken to use pure tin for soldering, which has a melting point of over 200 deg. C. Air ducts of ample dimensions are provided to insure a large volume of air being circulated through the core. The efficiency is 88 per cent, being only about 3 per cent lower than a standard machine having a temperature rise of 35 deg. C.

The exciter is a 3-kilowatt, 70-volt, shunt-wound machine with its armature mounted directly on the armature shaft of the main generator and its field yoke supported by the bearing brackets, enabling it to fit under the back ends of the generator armature windings. The illustration of the engine, generator, and exciter assembled shows far better than a written description the neatness and compactness of this generating set.

The speed of the motors is governed by a potential control, the generator being separately excited and the terminal voltage of the motors being varied by means of a rheostat in series with the exciting circuit. The simplest explanation of the controlling system is arrived at by considering the circuits separately. The armature circuit of the main generator comprises the armature fuse, two contactors in series, reverser, and the two motors. The motors are connected in series or in parallel, according to the position of the controller handle, and they are grounded to the truck framework, while the solenoid coils for operating the contactors are energized by a storage battery floating across the field circuit. The reverser is operated, as usual, by a separate reverser handle on the controller.

The current from the exciter passes around the field of the main generator and through the rheostat; the function of the controller is to cut in and out this rheostat, as occasion demands.

A storage battery which floats on the exciter circuit is used for supplying the lighting circuits and its charging and discharging is controlled by means of a reverse current relay which permits the lights being supplied directly from the exciting circuit or from the storage battery, according to the voltage of the exciter circuit. A Tirrill regulator is employed for regulating the voltage on the lighting circuit. These arrangements enable the car lights being used when the engine is at rest.

The master controller gives seven steps with the two motors connected in series and eight steps with the two motors connected in parallel. It is provided with four handles, three of which are mounted one above the other on concentric shafts. The function of the top handle is to advance and retard the ignition of the engine, the second controls the throttle of the engine, while the third handle controls the generator field resistances and the contactors, which establish the circuit for the motors, besides transposing the motor connections from series to parallel. The fourth handle operates the reversing switch and controls the direction of rotation of the motors.

The car is heated by passing part of the exhaust gases through pipes suitably located in the car body.

GENESIS OF THE FORMATION AND DEPOSITION OF THE NEVADA DESERT GOLD, SILVER AND COPPER MINES.

By Dr. WILLIS E. EVERETTE.

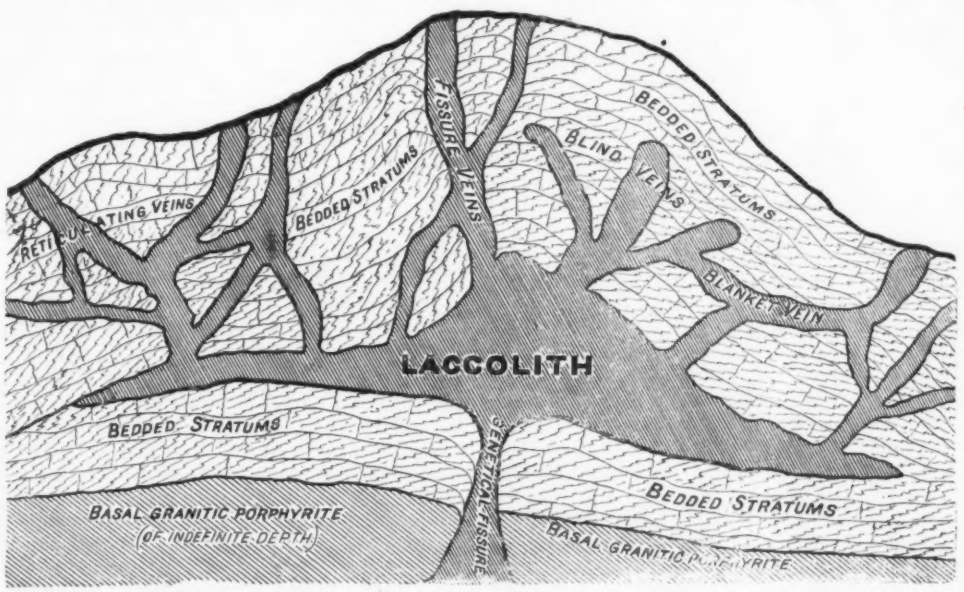
THE "ores" of the Nevada desert are found in direct and reticulating fissures, both in the "bedded stratums" and in the porphyritic rocks in the granitic country formation.

These crevices and fissures are filled with a polylithic mass of brown and white "calcic spar" in a soft talcose quartz, together with quartz-porphyrite and intensely hard quartz-rhyolite in a more or less "brecciated" condition. The geological condition seems to be that these "ore bodies" will undoubtedly increase in size and quantity of vein material, by vertical sinking on the veins and fissures above the underlying various "laccoliths," which were formed underneath the present desert "floor" at the time when this desert was then the bed of a part of the great Gulf of California, which formerly extended far inland to the northward of where it is at this day. What the future values of these "ore bodies" will be, however, I cannot at present make any comment; as there is much investigation yet to be made ere any definite knowledge of the "ore values" of the deep workings can be stated.

There is no doubt that the genesis of the ore bodies in these vertical fissures and reticulating crevices in these bedded strata, and prophyritic and rhyolitic "breccias" of the Nevada desert mines, was due to an upward radial deposition and percolation from the upthrust of a series of immense "laccoliths" (see accompanying illustration) which no doubt exists far below the surface of these Nevada desert plains, and from which uprises the mountainous masses of formations in which these Nevada desert mines are located.

The general character of the Nevada desert "ore," as to gold, silver, or copper, varies very much, according to the district the "ore" is taken from. One "upthrust" may be nearly all of a copper value. Just across the intervening desert valley, another "upthrust" may be mostly all silver values; and in an opposite direction may be another "upthrust" containing enormous gold values; and yet again, only a few miles away, may be another "upthrust" of a mixture of silver, gold, lead, and copper values. The entire mass of isolated and irregular mountainous "upthrusts" in these Nevada deserts seems to vary in regard to the quality of the "ore values" in so great a degree, that it is impossible to determine by looking at the surface rocks just what kind of a "camp" it is going to be—whether gold, silver, or copper. It is certainly a wonderful rock formation, boldly rising out of a former inland ocean in isolated and irregular mountainous masses; and its economic mining future looks very promising, though the chief trouble at present in its economic development is the question of sufficient transportation facilities and local smelting furnaces with cheap fuel.

The general character of the "ore material" in the veins and fissures is a mixture of massive crystallized brown and white calcic spar, along with brecciated rhyolite, novaculite, porphyrite, and quartz, all in various degrees of friable softness together with great hardness, in an indefinite talcose and brecciated condition. The richest ore seems to be mixed with a crushed quartz and a densely hard brecciated rhyolite in various forms of composition and hardness.



VERTICAL SECTION OF LACCOLITH, SHOWING THE GENETICAL FISSURE, AND THE RADIATING UPWARD FISSURES, IN THE BEDDED STRATA.

These fissures are filled with ores, quartz, and lime spar, which were deposited by the thermal pulsating springs of alkalinely silicated waters rising from the laccolith, while under volcanic pressure and heat.

Throughout this mass is usually found crystalline quartz, novaculite, andesite, and rhyolite together with diorite and a form of metamorphic porphyrite, which usually contains both ferric and cupric sulphides, along with a small amount of auric tellurides, both sylvanite and calaverite.

This entire polylithic mass is all jumbled and brecciated into one another in a very irregular composition, and is cemented into close contact as a solid rock by irregularly reticulating veins of aqueously-deposited silica and calcite spar, which came upward from the underlying "laccolith" in the shape of boiling thermal springs and pulsating geysers of alkalinely silicated waters with powerful volcanic pressure, permeating all of the upward radial fractures and fissures, decomposing a part of the rock of the fissure walls, and in combination with acid surface waters deposited its mineral content in the condition we now find it.

The geological possibilities relative to the salt and borax deposits, and to coal and to petroleum, and to bituminous rock in these "Nevada deserts" will be taken up in another article during the present year.

ANNEALING OF STERLING SILVER.

IN the American Chemical Society's Journal, W. H. Walker points out that "sterling" silver (7.5 per cent copper and 92.5 per cent silver) suffers in its physical properties under mechanical treatment, becoming hard, stiff, and brittle. Annealing by heating to low redness eliminates these undesirable features, but produces on the alloy a scale of black copper oxide which diminishes the luster and marke value of the goods. This undesirable appearance is found to penetrate the silver alloy to a distance roughly proportional to the number of times that annealing has been resorted to. Immersion in strong nitric acid is necessary to dissolve away the alloy until the darkened portion has disappeared. The author attributes the appearance of this black surface layer to the formation of copper oxide during annealing, and therefore urges that this process should be carried on in an atmosphere containing little or no oxygen. An attempt to use illuminating gas was unsuccessful, as although the oxide was eliminated, minute blisters were produced; these are ascribed to the penetration of the silver by hydrogen or hydrocarbon gases, which reduce the copper oxide to metallic copper with formation of water. Experiments showed that hydrogen, methane, and acetylene were very active in producing blisters, while nitrogen and carbon dioxide were entirely inert, carbon monoxide occupying an intermediate position. The most desirable atmosphere from a chemical point of view is one containing enough reducing gases to prevent the penetration of the small amount of oxygen present, and enough inert gas to prevent the penetration of the reducing gases. Practically this is best obtained from a producer delivering a gas containing approximately two-thirds CO_2 and nitrogen, and one-third CO with a small amount of hydrogen.

FACTS ABOUT COAL.

THE Irrigation Congress recommended government ownership of coal mines, to be effected by the government retaining title to coal lands which have not yet been alienated, though allowing acquisition by citizens of the surface of the ground for farming and other uses. The Geological Survey also favors this policy.

The discussion of this subject makes interesting some facts on the early occurrence of coal in the United States. The first information is in the journal of Father Hennepin, who, in 1679, recorded a coal mine on the Illinois River, near the present city of Ottawa. Coal was first mined in Virginia about seventy years later.

The mining of anthracite coal in Pennsylvania began in 1790, and it is said that fifty-five tons were shipped to Columbia, Pennsylvania, in 1807. More than 50 per cent of the total production of coal in the United States, from 1814 to the close of 1906, or 3,540,000,000 tons, was mined in Pennsylvania.

A publication on the production of coal in 1906 will soon be ready for distribution by the Geological Survey.

In a recent issue of the Journal de Physique Messrs. Waidner and Burgess discuss the melting points of tungsten and tantalum. The testing points for the thermometric scale from 0 deg. to 1,200 deg. C. are given by (1) the melting point of zinc, 419 deg.; (2) of antimony, 630.5 deg.; and (3) of copper, 1,084 deg. The temperatures given by both the gas-thermometer and the Pt-Rh thermo-couple agree at these points. Above 1,200 deg. extrapolation is necessary. The authors employ the law of Wien, connecting the temperature with the intensity of the light emitted, and a Holborn-Kurlbaum optical pyrometer. They find that in the calibrated portion of the thermometric scale Wien's law is much more accurate than the empirical parabolic law generally employed. They have previously found that the melting-points of palladium and platinum are 1,546 deg. and 1,753 deg. Applying similar methods and making ingenious corrections for the deterioration and the selective radiation of the metal filaments tested, they find that the melting point of tungsten is 3,080 deg., and of tantalum, 2,910 deg.

THE STREAM OF PLANETOIDS.

A NEW LAW FOR ITS LOCATION.

BY DR. JULIUS FRANZ, DIRECTOR OF THE OBSERVATORY AT BRESLAU.

THE history of the planetoids between the orbits of Mars and Jupiter has passed through various surprising stages. The most notable departure which changes the accustomed notion of our planetary system is the discovery in 1906 and 1907 of planets which are not restricted to the zone between Mars and Jupiter. For this reason a glance at the development of our knowledge of this stream of planets may not be amiss at this time.

In the first place, the planets known for ages—Mercury, Venus, Earth, Mars, Jupiter, and Saturn—are so arranged that the interval between any two consecutive orbits, passing from within outward, almost exactly doubles. This phenomenon was first emphasized by Titius, professor at the University of Wittenberg, and is consequently known as the "Series of Titius." However, between the orbits of Mars and Jupiter the distance was so great that at this point a member of the Series of Titius was wanting. Indeed, Kepler, in his "Mysterium Cosmographicum" of 1596, had introduced at this gap a regular body as the symbol of an undiscovered planet. When Herschel (1781) discovered Uranus beyond Saturn, it came to light that this planet also continued with exactness the Series of Titius outwardly. Consequently, this series, although without a mathematical basis, gained in respect, and at the end of the eighteenth century the conviction grew with astronomers that between the orbits of Mars and Jupiter there was another planet. So in 1799 there was formed among them an association for the purpose of searching for the missing planet. It was desired to include Piazzi, the deserving director of the observatory at Palermo, in this group. But before he learned of this purpose, he found on the first day of the nineteenth century the sought-for planet, without, however, immediately recognizing it as such. In fact, in the course of his observations upon the fixed stars, a contradiction had come to light, and this manifested itself notably in the circumstance that a little star, first observed on January 1, 1801, of the eighth magnitude, had a somewhat different position on January 2, and during the following days advanced in the same manner. He followed the wandering star until the middle of February, and then, when it had disappeared in the evening twilight, sent its calculated positions to the astronomer Bode by mail to Berlin, where the letter arrived months afterward, having been delayed in transmission across the Alps by the disturbances of war. Piazzi spoke in his letter of a star-like "comet," which he had discovered. For the discovery of a planet had, apart from Uranus, never yet occurred. Consequently, this lay outside the realm of consideration. It soon transpired that the calculation of the orbit of the new celestial body could not be adjusted, for the observations permitted harmonization with no sort of parabolic cometary orbit. Then the supposition arose that it was a planet, and that it had an elliptical, circular-like orbit. But how was such a path to be calculated? The case had never yet arisen that a planet, which had a relatively rapid motion, which had been under observation for a short time, and the orbital velocity of which was unknown, required the calculation of its orbit. For Uranus, the only hitherto discovered planet, had (on account of its great distance) such a slow motion, and (on account of its high degree of brightness as a star of the sixth magnitude) such a long period of visibility, that it was easy, after it had disappeared from sight behind the sun, to pick it up again in the nocturnal sky of the following year, even without orbital calculation.

At this juncture, Karl Friedrich Gauss, but twenty-four years of age, proposed to himself the problem of calculating an elliptical orbit from the observations, and solved it, in that he devised an entirely new method, which thereupon was applied in all the following planetary discoveries, and thus played an important part in the astronomy of the nineteenth century. In accordance with his calculation of the orbit, the wandering star was picked up again on January 1, 1802 (exactly one year after its discovery), by Dr. Olbers at Bremen in an entirely different part of the sky and in the midst of many fixed stars similar to it. It was recognized again as a planet on account of its advance from night to night. Its orbit lay between that of Mars and Jupiter. It thus proved to be the hitherto missed and long-sought-for member of the Series of Titius. Piazzi named the new planet Ceres, after the mythological Sicilian goddess of protection, and gave her the sickle for a calendar symbol.

Upon observing Ceres further, Olbers found on March 28, 1802, a second little planet, Pallas. Harding discovered (1804) Juno as the third, and Olbers (1807) Vesta, the brightest of all the planetoids, as the fourth—all lying between the orbits of Mars and Jupiter. There were thus, in contradiction to the Series of Titius, instead of one planet, four present in this zone. The following decade brought no further discoveries.

In the meantime, an astronomical amateur, Postmaster Hencke at Driesen, was searching with his telescope the quarter of the sky lying opposite the sun, year in, year out, night by night. He would map all the little stars and compare them again in the following nights. Although Prof. Encke at Berlin repeatedly admonished him that his efforts would remain unrewarded, he was not discouraged, and at last (1845) he found a new planetoid, to which (as well as to his daughter) he gave the name Astræa, and in 1847 a second, Hebe. Since then, no year has passed without the discovery of one or more new planets. This may be attributed not only to the example of Hencke, but also to the perfecting of the telescope, and to the publication of printed special star charts upon the basis of the localizations of numerous fixed stars. Thus one could enumerate in the year 1868 100 little planets; in 1879, 200; 1890, 300; 1895, 400; 1903, 500; and 1906, 600. Consequently, instead of one looked-for planet, a complete stream is present between Mars and Jupiter.

The zeal of the astronomers directed itself toward the observation of the numerous newly-discovered heavenly bodies. And all considered, it was an honor to take part in the calculations. At the same time, that varying quarter of the ecliptic which lies opposite the sun, and in which the planets reach their "opposition," and therewith their perigee and greatest brilliancy, was searched by astronomers for new ones. As the most fortunate discoverers are to be mentioned Hind (at London), Goldschmidt, an amateur (at Paris), Gasparis (at Naples), and Robert Luther (at Bilk near Düsseldorf). Chacornac and the brothers Paul and Prosper Henry discovered at Paris, during the construction of stellar charts of the zodiac, a number of planets among the numerous charted small fixed stars. From America, Watson at Ann Arbor, and C. H. F. Peters (born in Holstein) at Clinton astonished the world by their numerous discoveries. But Johann Palisa should be named in advance of all. Gifted with an excellent memory for star groupings, he discovered 83 new planets, the majority with a small telescope while director of the observatory at Pola. Later he moved to Vienna, where large refractors were available. But the number of small stars now becoming visible changed the accustomed groupings, and thus hindered rather than favored the further discovery of new planets. In Vienna he now made himself especially serviceable by following up the faint planets already discovered.

Planetary calculations have brought to astronomy many good methods and devices, and it must be considered as an especial triumph of science that we are able to recognize and find again with the aid of orbital calculation so many wandering stars, similar to one another and to the fixed stars. According to the method used by Gauss, they are sought, and betray their planetary character (if their position is measured twice during an evening within the interval of an hour) through their proper motion. In connection with the repeated appearances of the same planet, the mathematician must also allow for the "disturbances" which Jupiter and Saturn exercise through their attractions. This apparently difficult task is accomplished, following the example of the Berlin astronomer Encke, by means of the elegant method of mechanical quadrature, in that in the integrations of the differential equations the literal calculation is replaced by a numerical one. The astronomical Recheninstitut at Berlin acts as the official center for all these calculations, and publishes yearly in the Berliner Astronomisches Jahrbuch, the ephemerides of the planets, i. e., the tables which state from day to day their position in the sky. In this way, Germany's capital has become the center for the care of the planetoids.

According to the minute measurements of Barnard, Vesta (No. 4) and Ceres (No. 1) have each a diameter of 652 kilometers (405 miles), while Pallas (No. 2) has a diameter of 518 kilometers (322 miles).

The rest appear as mere points, and are immeasurably small. However, Weiss estimates, having regard to their brilliancy, the largest of them at 342 kilometers (212 miles) and the smallest at 16.14 and 10 kilometers (10 and 6.2 miles) in diameter.

There is no doubt that many small bodies are in motion among them whose diameters are of 1 kilometer (3,281 feet), of perhaps 1 meter (39.37 inches) and even of 1 millimeter (0.039 inch); and that the majority, on account of their faintness, are not visible to us. But do we not see in the winter a weak shimmer of light opposite the sun—the so-called "reflection of the zodiacal light"? This may be explained most simply by the reflection of the solar light from many little bodies; thus, from the well-nigh dust-like stream of the small and smallest planets, every one of which reaches its relatively greatest brilliance at its opposition with the sun. These little bodies, on account of their slight power of attraction, can have no appreciable atmosphere and no bodies of water. Besides, they cannot markedly vary from the spherical form.

They are of no immediate use to mankind. Their orbital calculations can be used neither for the determination of time nor for the guidance of navigation. But the ideal beauty of these planets is that their reappearance is continually a test of the correctness of the calculation, and that they continually anew exhibit the validity of Newton's law of the universal attraction of all bodies.

Highly theoretical investigations have been carried out by Hansen, Glydén, Poincaré, and George Darwin, which have gained from orbital computation continually new points of view, and have led to beautiful mathematical ideas. Here belongs the question as to the simple relations of the times of revolution of a planet and of Jupiter as the most important disturbing planet, or the so-called libration of the orbit, as it comes to light in some measure with Hecuba (No. 108) and with planets of the Hecuba type. The value of the little planets is thus not to be sought upon the practical, but upon the theoretical side. The most beautiful thing in astronomy, its crown, are the mathematical laws which result from computation. Bessel said, and not with injustice, that astronomy presents to mathematics the worthiest and most exalted tasks, and their solution has resulted repeatedly in an "elegant" method, if one may here employ a customary mathematical expression.

But the trouble and time which hundreds of planets uninterruptedly required for their rediscovery and the correction of their orbits, are so considerable that the question was presented whether the gain was worth all the trouble. So, in the eighties of the nineteenth century, a party of astronomers demanded that a choice be made of the planets, and that only a part be followed up with accuracy, but that the rest (since indeed they apparently showed merely the same phenomena) be abandoned without attention. But surely that would not have lessened the labor. For, since one was unable to forbid the discovery of planets, it would have led to this, that the majority of the planets would be lost and would be continually discovered over again. Prof. Tietjen at Berlin found a middle course. Since 1891, he abandoned the yearly ephemerides (tables which gave the course of the planets during the entire year), and stated merely in one line, for each planet, time and place of opposition and the daily variation in its position. For selected, important, and interesting little planets, opposition ephemerides were printed, which gave the position of the planets daily with exactness for six weeks of their best visibility.

This economy was necessary, for in December, 1891, Max Wolff at Heidelberg began the photographic observation and discovery of the little planets, and this has resulted in an especially rich gain. Repeated and hour-long exposures of the photographic plate—in connection with which the telescope follows by means of clockwork the stellar position, ever changing during the course of the night with respect to the horizon, and in connection with which changing position the errors of the clockwork may be corrected by means of a precision screw—permit the fixed stars to register themselves upon the plate as points, the moving planets as short faint strokes. And these latter are discovered by means of the microscope after development and fixing. In this way more planets have been discovered in Heidelberg since 1892 than before. Charlois at Nice emulated Prof. Wolff in that he applied the same photographic method. Thus there has begun since 1892 the new era of astronomical photography.

The increase of the discoveries by means of photography since 1892 has induced astronomers to introduce

provisional designations. Up to this time all the planetoids had—following the example of the first, Ceres—been designated with feminine, above all with mostly mythological and classical names. Instead of the calendar symbols (sickle of Ceres, etc.) the natural numbers had long since been introduced; as far as possible arranged according to the time of discovery.

Since 1892, newly-discovered planets have received provisional designations of the letters A, B to Z; AA, AB to AZ; BA, etc., to ZZ; and with the number of the year preceding. Only if it has once been established that they could be observed sufficiently long to guarantee finding them again, and that they are identical with none of the earlier planets, do they receive the next numeral and name, and thus become included in the system. In this manner is avoided unnecessarily increasing the lost planets of the system. In 1907 the crucial moment has come in which the planet ZZ has been discovered, and the series of provisional designations begins again.

Up to nine years ago, all the 432 planetoids moved in the zone between the solar orbits of Mars and Jupiter; and, indeed, all with same right-handed motion. Consequently, no little attention was attracted when on August 13, 1898, Witt at the Urania at Berlin photographically discovered a planet with an unusually rapid motion. The computation of its orbit showed great proximity to the earth and a mean solar distance of 1.46 astronomical units; thus less than that of Mars (1.52). In astronomy the mean solar distance of the earth is taken as unity. Was this celestial body to be counted in with the stream of planetoids between Mars and Jupiter?

Since the possibility existed that still other planets might be discovered which were not confined to the zone between the orbits of Mars and Jupiter, it was determined to include it indeed with the planetoids with the numeral 433, but to distinguish it by the masculine name Eros.

Two months later Wolff, still at Heidelberg, discovered the planet Hungaria (No. 434). This, next to Eros, is with its solar distance of 1.94 units the innermost planet of the stream. Its orbit lies, however, entirely in the zone beyond the orbit of Mars.

Eros has a rather eccentric elliptical orbit, and thus approaches at the time of its perihelion three times as near to the orbit of the earth as Mars and the nearby planetoids. Through this circumstance it acquires a highly practical significance in respect to the determination of the true size of the entire planetary system. From the laws of the orbits is found, in fact, very accurately (to six decimal places) the relations of the planetary distances. On the other hand, these distances themselves are very little known. They are inversely proportional to the solar parallax (8.80 sec.), of which one can be confident of but two decimal places. By means of observation of the transits of Venus, of observation of the nearer planetoids, of Mars, of the velocity of light, and of the parallactic lunar equation, great pains were taken in the last century to determine with more exactness the solar parallax, and thus the extent of our entire planetary system. Now it appears that the observation of Eros yields this quantity with three times the exactness of the earlier methods, and that nothing else than the observation of the lunar orbit for the determination of the parallactic equation can compete with it. Thus the discovery of Eros performs a useful service for astronomy.

Just as Eros goes beyond the zone between the orbits of Mars and Jupiter toward the inside, so three lately-discovered planets do so toward the outside; though, to be sure, to only a small degree. These have also received masculine names.

In the first place, let it be stated that the mean solar distance of Jupiter amounts to 5.203 units. On February 22, 1906, Wolff at Heidelberg found the planet TG (No. 588), Achilles, mean solar distance 5.253, eccentricity 1/7. On October 21, 1906, his assistant Kopff discovered, at the same place, VY, Patroclus, mean distance about 5.204, eccentricity 1/7. On February 10, 1907, the same person found XM, Hector, with 5.278 mean distance and 1/27 eccentricity. These three heroes of Troy play, in addition, a noteworthy part through the fact that their right ascensions differ from that of Jupiter about 60 deg. Sun, planet, and Jupiter form what is thus almost an equilateral triangle. Now, Lagrange showed that the special case of the problem of three bodies is capable of mathematical solution when the three reciprocally attracting bodies form an equilateral triangle. They would then describe about each other, as well as about their center of gravity in the mathematical sense, similar ellipses. In this process, they would be able to approach and recede from each other, but in such way that the triangle, at whose vertices they were, would continually remain equilateral. The Swedish astronomer Charlier has put forth the conjecture that this unusual case is here really present. Poincaré at Paris has, in fact, proved that the triangle need not be so precisely equilateral, but that then relatively small determinate variations ("librations") from the equilateral condition would have to enter. It would be wonderful if this should here be realized. The Trojan heroes would then manifest a harmony of the spheres which had never before taken place. We believe, indeed, that this beautiful dream—hitherto known only as a mathematical castle in the air—will not be completely realized, for the reason that the orbits of Achilles, Patroclus, Hector, and Jupiter have somewhat different eccentricities, and do not move exactly in the same plane. The disturbances, which Saturn and other planets exercise, would (one may certainly say without hesitation) be overcome by the libration.

However, the approximate exhibition of harmony promises an attractive display; and though it may cease at some later date, Achilles, Patroclus, and Hector may get into the immediate neighborhood of Jupiter and remain there for a long time. Their orbits would then be considerably transformed through his influence.

In conclusion, it is to be mentioned that Metcalf at Taunton, Mass., has brought the technique of observation to a higher degree through the fact that he has had his photographic telescope follow the mean motion of the planets. In this way the planets are shown in the shape of points and considerably brighter, the stars in the shape of faint strokes. Thus he has found in 1905 two, and in 1906 twelve new planets, and his improved method will probably soon receive general introduction.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Deutsche Revue.

KOUMISS.

THIS liquid, which resembles kefir and which is also called *vinum lactis* or *lac fermentatum*, plays a very prominent part in the life of the people of Siberia and Russia, for their livelihood is furnished almost exclusively by the horse; meat for food and milk as drink, etc. For the production of koumiss serves mainly the milk of mares, less frequently that of camels or asses. In consequence of being in spirituous fermentation, koumiss froths; in odor and taste it resembles buttermilk or slightly sour whey, and it contains caseine in form of a fine suspended curd. Good koumiss is similar in taste to kefir, but less fine than the latter. In Russia sick people, especially those affected with tuberculosis, are sent for the summer for the purpose of a koumiss-cure to some Cossack village in the steppe. A few hours' distance from St. Petersburg there exists even a sanitarium where mares are kept and very thoroughly cared for for the sake of obtaining koumiss. Koumiss is made by placing old or sun-dried koumiss deposit in a vessel and adding some freshly secured mare's milk to it. This is then stirred for 15 minutes and allowed to stand over night. On the next day freshly milked mare's milk is added anew and well stirred from time to time until evening. In this way toward evening a weak koumiss is obtained. The fresh milk is, in this process, at once violently beaten by means of a perforated board. Then to 10 parts of milk one part of ready koumiss is added and allowed to stand, with constant stirring, for from two to three hours. After between two and three hours the liquid is filled into bottles and taken to a cool place. After from three to seven days violently frothing fermentation sets in with formation of an agreeable prickling, sweet-sour taste accompanied by an after-taste of sweet almonds; the color is milk white, the odor is sour and reminds one of the specific odor of the horse. The wholly fermented product forms the real koumiss which contains more alcohol, carbonic acid, and lactic acid than kefir. Some nomadic tribes prepare out of koumiss by means of distilling a sort of milk cordial, the so-called araca, which, however, on account of its high contents of volatile fatty acids, has anything but a pleasant taste. Better is the arsa which is obtained by rectification of araca. We distinguish three kinds of koumiss: fresh, one day old; older or medium strong, three to five days old, and five to seven day old or strong koumiss. In Germany, Austria, and Switzerland attempts have been made to produce koumiss also from the milk of cows; these were successful, but the koumiss prepared in this way has not been disseminated any further, for which reason it is to be supposed that koumiss, in spite of its hard and crude taste, possesses qualities which cannot be imitated by the milk of cows.

In the case of koumiss cures two or three glasses are taken daily, later on four bottles per day, and the patient ends by living almost entirely on koumiss. At first a slight degree of intoxication shows itself, then relaxation, weariness, and inclination to sleep; the latter remains throughout the entire cure, and in the case of using it from four to six weeks a considerable improvement of the nutritive condition takes place.

In the formation of koumiss, two fungi are said to be active, a lactic acid bacterium and a yeast. Vogeler found in koumiss *Torula cerevisiæ* and *Penicillium glaucum*. Schlipin found in koumiss a saccharomyces fungus, *bacillus acidi lactici*, and the koumiss fungus, an independent organism which has so far been found only in koumiss. It is a true, but not a strict, aerobic; it may, under circumstances, develop also in the atmosphere and grows better on acid than on alkaline nourishing substrata. Its optimum is at a temperature of between 20 to 30 deg. At 56 deg. C. it is killed after half an hour. It forms no sporules, multiplies by means of division, possesses independent movability and power of peptonization; moreover, it is capable of splitting sugar into alcohol and lactic acid. It is the principal fermenting fungus of koumiss, but begins its activity only then when the life conditions necessary have been prepared for it by *bacillus acidi lactici*, the common lactic acid bacterium of milk and the saccharomyces. Its effect, therefore, comes only into consideration in the case of symbiosis with *bacillus acidi lactici* and saccharomyces.

According to Vieth one and eight day old koumiss had the following chemical composition:

One-day-old.—Water, 90.14 per cent; alcohol, 1.69 per cent; lactic acid, 0.64 per cent; lactose, 4.34 per cent; total albuminoids, 2.20 per cent; caseine, 1.15 per cent; albumose, 0.30 per cent; lactoproteine plus peptone, 0.75 per cent.

Eight-day-old.—Water, 91.02 per cent; alcohol, 2.14 per cent; lactic acid, 1.10 per cent; lactose, 2.30 per cent; total albuminoids, 2.16 per cent; caseine, 1.18 per cent; albumose, 0.26 per cent; lactoproteine plus peptone, 0.72 per cent.

Many curative qualities are ascribed to koumiss, and since tuberculosis is absent in the Russian and Siberian steppes where it is being taken, it is, consequently, often successfully applied against this disease, and there have also been erected sanatoriums for tuberculosis in the territory of the Kirghises. It is an excellent food, on account of its contents of peptone, lactic acid, and alcohol, very easily digestible and promotes digestion; in the case of stomach troubles, scrofula, chlorosis, and anæmia it is being used with great success.

Lastly, mention should be made of the "mazun" of the Armenians from the milk of the bison or goat, but is also prepared from the milk of cows, and possesses a pleasant acid taste similar to that of kefir. It serves as acidifying material in the case of churning wherewith the butter assumes a pleasant aroma. Moreover, it serves as a beverage, and also for the production of various milk foods. The preparation is carried on in a way similar to that of kefir and koumiss, the lactic acid and alcohol fermentation probably takes place here also in a symbiotic manner. Nine kinds of yeasts are found, in addition to these also an anomalous yeast and the mazun-yeast, finally a micrococcus which hydrolyzes lactose and cane-sugar. The yeasts cause the peculiar aromatic mazun-odor. The "leben raib" of the Egyptians, a sweet-sour refreshing beverage of pleasant taste and peculiar aroma, is also fermented milk resembling kefir, still as contrasted to kefir it is curdled in flakes. In Egypt it is prepared from the milk of bisons, cows, or goats by mixing fresh milk with old "leben raib."

From leben raib five organisms have been isolated: a streptococcus growing in long chains, another streptococcus and a small bacillus, then a mycoderma yeast, the latter having probably particular influence upon the peculiar taste of leben raib. The "yaourte" of the Greeks and Turks is very similar in taste to leben raib; it is, however, very questionable as to whether it is identical with leben raib, for it is said to contain different kinds of organisms.—From Pure Products.

ANALYSIS OF CONDENSED MILK.

ANALYSES of five samples of machine-skimmed condensed milk show that fat may vary from 0.30 to 1.26 per cent; casein, 9.05 to 11.10 per cent; sugar, 62.77 to 65.94 per cent; ash, 2.26 to 2.48 per cent; and water, 20.26 to 24.66 per cent. Boric acid is invariably found, being present in the proportion of 0.25 to 0.43 per cent. Other preservatives, such as formalin and salicylic acid, have not been found, nor was starch or viscogen. In three samples of full-cream condensed milk examined, the fat ranged from 8.20 to 11.13 per cent; casein, 8.37 to 10.95 per cent; sugar, 58.21 to 65.46 per cent; ash, 2.00 to 2.84 per cent; water, 13.04 to 18.70 per cent. Boric acid was present in two samples, 0.10 and 0.17 per cent respectively, while in the third none was found. A full-cream unsweetened condensed milk was found to contain fat, 10.13 per cent; casein, 10.86 per cent; sugar, 9.55 per cent; ash, 1.74 per cent; water, 67.72 per cent; boric acid, none.—F. J. Lloyd, Chemical News.

TEA FLOWERS.

THE buds of the tea plants, collected a few days before they expand, and dried, yield an infusion of very pleasant taste and agreeable odor; they contain about 2.1 per cent of caffeine, 2.65 per cent of ash, and 10 per cent of moisture. The sepals bear on their upper surface numerous one-celled hairs directed toward the apex, and exhibit in the mesophyl a wide layer of sclerenchymatous cells, varying greatly in size and shape, but similar to those found in the leaf. These characters allow of the identification of the buds.—E. Perrot and A. Goris, Bull. des Sci. Pharm.

ELECTRICAL NOTES.

A new type of direct-current meter has just been perfected which offers many advantages to the inspector, lamp salesman, and lamp manufacturer. The movements are built on the familiar d'Arsonval pattern, and are so placed with reference to each other and the scale as to render the energy consumption directly readable at the intersection of the volt and ampere indicator needles. A special feature is the design which enables the operator to read at one glance the pressure, current, and wattage on any lamp which may be inserted in a socket immediately above the meter. The instrument is equipped with three self-contained shunts, one of 150 amperes capacity, having conveniently-arranged binding posts, and a 1.5 and a 0.75 ampere shunt, which are connected within the base of the meter in such a manner as to be readily thrown into circuit at will. In order to test a lamp, it is necessary only to connect the attachment plug and cord to the lamp circuit, insert the lamp and read volts, amperes, and watts without computation. The different shunts may be easily placed in circuit by the adjustment of a small screw-plug at the top and right of the instrument. The two smaller shunts have universal connections. The voltmeter may have either a 150 or a 300 volt scale, or both. The most valuable feature of this instrument is the fact that accurate wattage measurement may be taken on a fluctuating load, since it is required to observe but a single point for such readings. The instrument is entirely self-contained and weighs less than 15 pounds complete.

A quantitative investigation of the losses due to the well-known "brushing" (Sprühen) of condensers when these are worked at high potentials is described by W. Eickhoff in Physikalischer Zeitschrift. Three condenser circuits were used: (1) a single jar, (2) four jars in series-parallel, (3) three parallel rows of three in series. The resultant capacity was in all cases 1,950 centimeters, and the self-inductance was also approximately equal. The only factor which is changed for the same spark-length is thus the p.d. between the armatures of each jar. The results are given in the form of curves plotted between sparking voltage and damping (δ). These curves are convex toward the axis of abscissæ. For (1) the minimum of δ is at 13,000 volts, and above this increases rapidly. For (2) and (3) the minimum is at 28,000 and 34,000 volts respectively, and the rise afterward is progressively less steep. It is therefore important, where sharp resonance is required to keep the loading of the condensers low, as by adopting the arrangement (3). The resonance curves are found to be unsymmetrical and the resonance point is shifted (always toward lower frequencies) when strong "brushing" across the dielectric occurs. This behavior is attributed to the fact that such "brushing" makes the dielectric partially conducting, and has as its result the same effect as if the condenser coatings were increased in size, by a variable amount; hence the variable change in frequency. Since the resonance changes also with increasing spark-length, the tuning in wireless telegraph stations should be effected at the spark-length which is to be employed. On immersing the condenser in oil the anomalous behavior is no longer observed. The results are a further argument in favor of condensers of diameter small compared to the length.

Experiences in bismuth refining by a combination of electrolytic and metallurgical processes are described by A. Mohn in a recent number of Electrochemical Industry. The raw material was a Mexican lead-bismuth bullion containing 14.5 per cent of bismuth. The stages in refining were as follows: (1) Electrolytic refining and recovery of the lead by the Betts process; (2) purification of the slimes; (3) electrolytic refining and recovery of the bismuth; (4) electrolytic refining and recovery of the silver and gold. The first stage consists in the electrolysis of the bullion using a 6 per cent solution of lead in fluosilicic acid, as electrolyte. The lead deposited upon the thin cast kathodes is pure, and contains only 0.01 per cent Bi. The slimes contain 84 per cent and are washed and then fused with caustic soda and soda ash to remove As, Sb, and Pb. The anodes for stage 3 of the process are cast from this raw material which contains 94 per cent Bi with 2.2 per cent Pb and 3.1 per cent Ag. The cells used for the deposition of the Bi contain anode boxes with lattice bottoms and perforated side walls. They are suspended in pairs across the electrolyzing cell, and are lined with filter cloth. A small wooden frame supports the anode rod and plate. This rod is cast with a copper pin in its head, for making connection to the cable conveying the current. Acheson graphite plates are used as kathodes, and are placed directly on the bottom of the cell. It is found unnecessary to provide a special joint between the kathode plates, since in time the deposited Bi fills in the crevices, and thus forms a joint. The electrolyte used is a solution of bismuth chloride containing free hydrochloric acid; it should contain 7 per cent Bi with 2 per cent free HCl. The current density employed is 20 amperes per square foot at the kathode, and three times this amount at the anode. The e. m. f. at the terminals of the cell is 1.2 volts. The Bi is deposited in the crystalline form, and when the anode boxes are removed it can be gathered from the floor of the cell with a wooden ladle. It is important to maintain the concentration of the electrolyte constant; this is accomplished by adding bismuth chloride or free HCl from time to time. The deposit becomes black and spongy if the amount of Bi in solution falls below the limit named, while bismuth oxychloride is formed, and the e. m. f. of the cell rises rapidly, when too little free acid is present. The Bi obtained is washed with hot water; it is then melted in plumbago crucibles and the slag is skimmed off. Should the color and appearance of the molten metal show the presence of impurities, caustic soda and sodium nitrate are added, and by this treatment all traces of Pb, As, and Sb are removed. A metal testing 99.8 per cent, the chief impurity of which is silver, is finally obtained.

ENGINEERING NOTES.

The Clyde shipbuilding statistics for the year show another record in ships launched and the horse-power of engines constructed, says the Engineer. Five hundred and nine ships were launched, of an aggregate of 620,000 tons, against 372 ships, of 599,000 tons last year. Eleven years ago the highest total was 400,000, and six years ago the half-million was reached.

In Stahl und Eisen H. Wedding and W. Müller write on alloys of copper and iron. The aluminothermic method is convenient for the production of these alloys. Copper alloys with iron in all proportions, reducing its malleability, but augmenting its strength and hardness. Metallographic examination of an alloy containing in per cent Cu 7.77, C 0.14 did not reveal any separate constituent, but the crystals were more curved and interlocked than in pure iron. Copper appears to hinder the formation of pearlite in higher-carbon alloys, and segregated cementite appears. Addition of copper lowers the transformation temperature to 1,150 deg. to 1,190 deg. F.

A contemporary says that the De Faria electric "valve" differs from the Nodon "valve" solely in the shape of the electrodes, which are claimed to secure automatic circulation of the electrolyte. Wattmeter tests of the efficiency of a 4 to 5 ampere set at the Laboratoire Central showed a mean efficiency of 53 per cent, the test lasting 7¼ hours; the hottest part of the electrolyte rose to 43.8 deg. Cent. At this temperature the efficiency was in one case even higher than at the lower temperatures. It is stated that the average efficiencies of larger sizes reach the following values: 10 amperes, 65 to 70 per cent; 30 amperes, 65 to 75 per cent; 50 amperes, 70 to 80 per cent.

The Simplon Tunnel was opened to regular traffic on the first of June, 1906, and the following are the results of the first year's operation. As regards the freight traffic, the amount which was taken into Italy was 27,400 (long) tons, while the amount passing from Italy into Switzerland figures at 29,400 tons. The total amount of freight transported upon the Simplon section is 56,800 tons. This includes the freight coming from France, and designed for Italy, and which is taken in transit across Switzerland and *vice versa*. It is to be remarked that the tariff for the transit freight only came into use in January, 1907, and as yet it has been but little applied, for different reasons. One of these is that the rates are not sufficiently known, and another that they do not offer sufficient advantages by the Simplon route, seeing that they are the same as are now used for freight taken by way of the Mont Cenis line. Thus we find that the 50,000 tons, in round numbers, which represent the Italian-Swiss traffic stand for the transportation of freight between the southern part of Switzerland and the valley of the Ossola in Italy. However, this figure is relatively high for the starting period of the Simplon line. A maximum of 100,000 tons was the figure predicted for the yearly traffic, including the transit freight. This result will no doubt be reached in the second year after the opening of the line. For the passenger traffic the results are not as yet published, as the material for the statistics will not be available for some time, but according to the count which has been made, it may be supposed that the number of passengers taken through the tunnel in both directions is 430,000 for the entire year. Some idea of the receipts can then be had, and if these are calculated upon the basis of the mean mileage rates for passengers and freight of the Swiss Federal railroads, we find the gross receipts in these two classes together to be about 42,000 francs per kilometer ($13,548 per mile). It will be remembered that the second parallel track is to be constructed when the receipts reach 50,000 francs per kilometer ($16,121 per mile) on the Simplon section. It will be remembered that when the first tunnel was built, a parallel galley was run through at the same time; this will serve as the basis for the new tunnel. Each of the tunnels will contain a single track and an overhead wiring system for the trolley of the electric locomotives.

TRADE NOTES AND FORMULÆ.

Vegetable Bouillon, According to J. Comby.—Be... good tablespoonful each of wheat grits, barley ... crushed maize, beans, peas, and lentils for three h... in three quarts of water. Add a little salt, strain, ... if the water has boiled away to less than a quart, ... water to make one quart.—Neueste Erfindungen ... Erfahrungen.

Cleansing of Gas Brackets and Chandeliers.—It ... very rarely that gas-brackets are gilded with real g... they are either dipped or lacquered. To cleanse, whe... gilded with gold or only its imitation, they must ... taken apart and the separate parts boiled in a st... lye for a few minutes and brushed with a soft br... Then pass through a solution of cyanide of potass... after this, wash in boiling water, and after drying ... sawdust, polish parts with a chamois leather. W... putting them together again, the parts should, if it ... necessary, be freshly varnished.—Neueste Erfahru... und Erfindungen.

Varnish for Machines.—Machine varnishes or gl... are commonly employed for painting agricultural ... chines and are obtainable in a variety of colors, ... as green, red, blue, etc. They must possess brill... luster and adhere to the iron almost as firmly as ... amel. They may be produced, of excellent quality, ... cording to the following recipe: In 120 parts of ... per cent alcohol dissolve 80 parts of soft Manila co... 40 parts of rosin, and when the solution is compl... add 30 parts of castor oil. This varnish is rub... down, in the proportion of 4 to 7, with any desi... bright color.

To Clarify Honey.—As the simplest method of cl... fying honey, a writer in Practischen Wegweiser rec... mends a process which consists in removing the ... sels directly from the centrifugal separator to a ... dust-free, warm place, where they are so disposed, ... covered, as to be subject to the direct effect of ... sun's rays. Thereby, according to the writer, the ho... remains thinly fluid for a long time, the light wax ... pollen particles are forced upward and form on ... surface a grayish yellow covering that can be carefu... removed with a wooden spoon. After 3 to 4 days, ... clarification is complete; the vessels full of honey ... covered air-tight with greased paper, and the honey ... ready for market.

Eradication of Tattoo Marks.—These are said to ... removable by the application of a paste of salicy... acid and glycerine. A compress is applied over th... paste and the whole secured with sticking plas... After about eight days, the paste is taken off, the de... skin removed, and the application of the paste re... peated (as a rule three times). Applications of c... ton wadding soaked in chloroform and kept in pla... by means of a bandage are also recommended; the fo... lowing mixture is also reported to be efficacious: Pe... sin 5 parts, water 25 parts, glycerine 75 parts, dil... hydrochloric acid 1 part. The pepsin is rubbed do... in a mortar with the mixture of hydrochloric acid a... water, the mixture allowed to stand for an hour, ... glycerine added, the whole left standing for thr... hours and then filtered.—Pharm. Ztg., Berlin.

The Most Advantageous Proportion of Water in C... crete.—Prof. Bach, of Stuttgart (according to the B... techn. Zeitschrift) has sought to determine by exp... ment the most advantageous quantity of water to ... used in concrete, and has arrived at the conclus... that the smallest quantity of water that is sufficie... to produce a concrete perfectly compressible by sta... ing, insures the greatest solidity. The production ... concrete bodies with a minimum of water, however, ... quires very practised workmen as well as great ca... fulness and always involves the risk that the concr... substance is not compactly solid throughout. T... employment of a larger proportion of water enab... workmen possessing less skill to produce a good c... crete. No minimum unit of water can be fixed, for t... degree of dryness of the sand, the gravel, and bro... stone or of the atmosphere, as well as changes of te... perature, etc., may in themselves make a greater ... smaller quantity of water necessary.

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